THE EVOLUTION OF NGA

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Index

List of Figures

List of Tables

Presentation of the study

The present document seeks, in light of the current "state of the art" and the national reality:

a) To assess the current situation with regard to next generation access networks (NGA)[1];
b) To present a number of relevant case studies at an international level;
c) To assess the situation regarding the characterization of existing networks and operator offers, the implementation of various government initiatives and regulatory measures undertaken in this regard.

After a brief presentation of the background to this study and its motivation, chapter 2 looks at the changing conditions of demand which have driven the deployment of NGA.

Chapter 3 briefly outlines the main NGA architectures adopted in Portugal and possible developments, making reference to possible solutions for PON (passive optical networks) unbundling and the solutions found in other countries.

The international scene is analyzed in Chapter 4, and an overview is presented of the evolution and current situation of NGA in several countries, including Germany, Australia, South Korea, USA, Finland, France, Greece, Holland, Italy, Japan, New Zealand, United Kingdom, Sweden and Singapore.

Chapter 5 outlines the developments seen in the European regulatory framework, examining the European Commission's (EC) Recommendation on NGA, and the "Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks" in light of the European Economic Recovery Plan. A brief presentation is then made of the European Regulators Group (ERG) - now BEREC[2] - in terms of the regulatory approach to NGA.

Chapter 6 characterizes the current state of development of NGA in Portugal, with particular focus on government initiatives, the actions of ICP-ANACOM, the activity of operators and community networks.

Finally, the conclusions of the study are listed in Chapter 7.

[1] "Next Generation Access Networks".
[2] Body of European Regulators for Electronic Communications.

1. Background

"Next Generation Networks" (NGN) are packet switched networks, supporting generalized mobility, allowing consistent provision of electronic communication services to users and enabling the use of multiple broadband transport technologies. They support a given level of quality of service (QoS) while the management of the network is independent of the management of the services. As such, they encompass various technologies - fixed and mobile - different hierarchical levels in electronic communications networks - interconnection network and access network - and facilitate the operation and integration of network management.

Given its potential to provide the user with bandwidth for Internet access which is much faster than currently provided, along with the high levels of investment involved, it is the access network with its various technologies which has been the focus of debate at international level.

According to EC Recommendation C(2010)6223, "next generation access (NGA) networks means wired access networks which consist wholly or in part of optical elements and which are capable of delivering broadband access services with enhanced characteristics (such as higher throughput) as compared to those provided over already existing copper networks. In most cases, NGA are the result of an upgrade of an already existing copper or coaxial access network".

Given the huge investments involved in NGA construction, most of which is directed at the construction sector and the need to maximize returns from recently made investments - particularly in the case of other authorised operators (OAO), and specifically those investments linked to the unbundling of the metallic pair local loop - and also with a view to the preservation of conditions necessary for competition in the market - the deployment of NGA calls for careful oversight and analysis by regulators.

In line with several similar entities at an international level, ICP-ANACOM has been developing a regulatory activity in order to put conditions in place which are appropriate to the proper development of NGA in Portugal.

Government also has an important role to play in implementing measures which – while always respecting the preservation of conditions of healthy competition - are aimed at ensuring a legislative framework and institutional conditions which support the speedy deployment of NGA. This is particularly, but not exclusively, the case in rural and/or

disadvantaged areas (particularly in terms of broadband services) where, due in large part to greater population dispersion, costs are typically two to three times higher (Ovum, 2008).

Within this framework, several operators in Portugal and around the world are deploying NGN on a large scale, particularly transmission and switching sections, but also access networks, implying the coexistence of these networks with traditional networks based on circuit switching.

All this is occurring in a context where investment in NGN/NGA is expected to have a significant social and economic impact, particularly in sectors such as education, health, social work, mobility, logistics, security and justice, contributing to the generation of skilled employment.

Given the limitations of available information, the uncertainty about future investments and market developments and the current economic climate, it is difficult to make robust predictions of a quantitative nature. Nevertheless, it is expected that NGN/NGA will contribute to the creation of a significant number of skilled jobs in Portugal, in addition to temporary jobs associated with the infrastructure deployment phase.

It is also expected that, with the widespread adoption of NGN/NGA, there will be a significant reduction in energy consumption (by networks/equipment) leading to a reduction in carbon emissions. According to estimates released by the International Telecommunication Union (ITU, 2008), the transition from traditional technologies to NGN increases network energy efficiency, contributing to a reduction of CO_2 emissions, which could total: (a) worldwide, a total of 460 Mt by 2020 and (b) at a European level, 330 kg per user over a period of 15 years. In a study (Ovum, 2009a), it was even reported that in the case of Sweden, if fibre was deployed throughout the country, the resulting energy saving would be equivalent to the output of a nuclear power station.

In this context, in June 2008, ICP-ANACOM published a pioneering study, awarded to Ovum (Ovum, 2008), on the impact of NGN on the market. This study identified the key drivers of deployment, characterized existing networks in Portugal, presented case studies at international level, analyzed the case of services using optical fibre, identified the key challenges of regulatory and government action and outlined a number of recommendations for the development of these networks in Portugal.

Meanwhile in June 2008, a public consultation was launched on the regulatory approach to NGA with the final was published in February 2009 (ICP-ANACOM, 2009). The goals of this consultation were:

a) To identify possible adaptations in the regulation of wholesale products in light of the expected evolution in access networks;
b) To enhance an appropriate regulatory approach which is transparent and consistent;
c) To compile information on any development plans for NGA which would enable ICP-ANACOM to better quantify the market impact and which would enable informed and timely action.

With regard to NGA, ICP-ANACOM has advised the government in the preparation:

a) Of Decree-Law no. 123/2009 of 21 May, which defined, at a basic level, the conditions of non-discriminatory access to physical infrastructure (e.g. ducts) in the national territory and established the legal regimes applicable to ITUR[3] and changes to ITED[4] which is already installed (an area which is incidentally also regulated by ICP-ANACOM);
b) Of Decree-Law no. 258/2009 of 25 September, which extends the obligations of access set out in Decree-Law no. 123/2009 to electronic communications companies and entities possessing infrastructure suitable for the housing of electronic communications networks used by the sector's companies, in addition to providing ICP-ANACOM which the means it requires to continue the inspection activities with are incumbent upon it pursuant to Decree-Law no. 123/2009;
c) Of the Public Tenders for the installation, management, operation and maintenance of high-speed electronic communications networks in rural areas.

Around eighteen months after the publication of the study by Ovum (2008), this paper seeks to present relevant case studies at an international level and report on the current situation with regard to NGN/NGA in Portugal, in particular with respect to the characterization of existing networks and operator offers, the implementation of various government initiatives and the various regulatory measures undertaken in this regard.

[3] ITUR - Infra-estruturas de telecomunicações em loteamentos, urbanizações e conjuntos de edifícios (Infrastructures for telecommunications in housing developments, urban settlements and concentrations of buildings).

[4] ITED - Infra-estruturas de telecomunicações em edifícios (Telecommunications infrastructure in buildings).

2. Demand

According to statistical information published by the ITU (ITU, 2010) in October 2010, the number of internet users worldwide doubled over the preceding five years, exceeding two billion users as at the end of 2010.

Also according to ITU statistics, the number of subscribers to 3G services, worldwide, has increased from 72 million in 2005 to 940 million in 2010; these services, which in 2007 were present in only 95 countries, are now available in 143 countries.

The ITU considers that the current trend points towards increasing use of data applications (mobile) rather than voice. This trend is reflected in the growing number of text messages sent, tripling in the last three years to reach 6.1 trillion[5] in 2010, or put another way, 200 thousand messages sent every second.

With broadband content growing rapidly, along with Internet based applications, there is growing demand for higher-speed broadband connections. This, associated with the sharp increase in new broadband users will lead to an exponential increase in the volume of information on the Internet and of traffic.

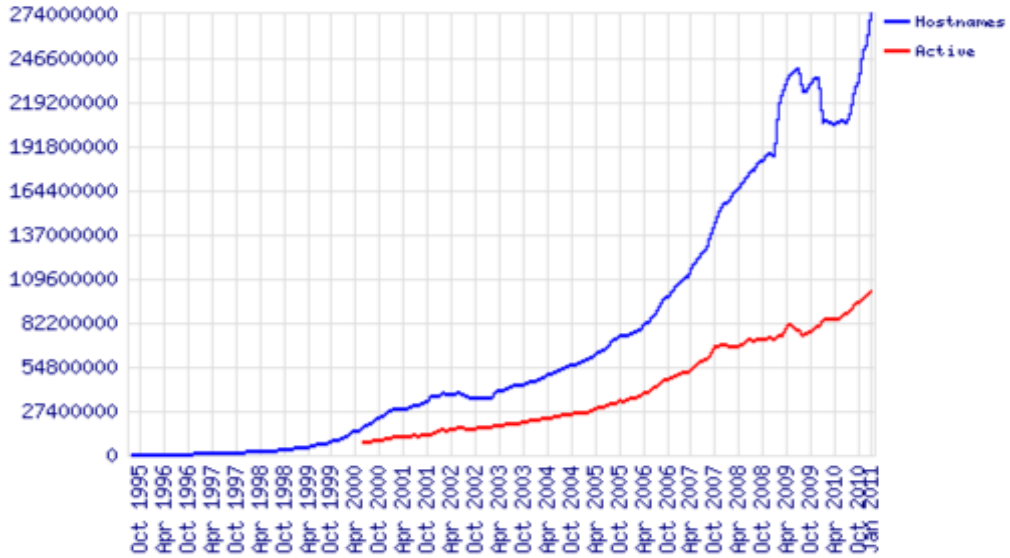
The volume of information on the Internet and traffic volumes have been growing at an exponential rate (due largely to the proliferation of video, audio and image sharing, the increasing number of online game players and, in parallel, the mass take-up of social networks), while bandwidth remains limited and susceptible to a "flood" of data corresponding to multiple exabytes.[6]

This increased volume of information/traffic is visible in the evolution reported in the number of websites between 2000 and 2010 (see Figure 1) and in the evolution of traffic. At the end of 2000, there were around 8.2 million active websites in the world, whereas by the first quarter of 2010 there were around 84 million, representing an increase over the period of 924%.

[5] 6.1 thousand billion.

[6] According to the prefixes adopted by the International System (IS), exabyte is a unit of information equal to 1,000,000,000,000,000,000 bytes or 10^{18} bytes.

Figure 1 Total websites in all domains (October 1995 - January 2011)



Source: Netcraft

The increase in traffic was mainly due to demand for services such as video over the Internet (downloadable video[7] or streaming video[8]), online games / virtual reality, IPTV[9], applications which allow content sharing between users (peer-to-peer)[10], portable devices with Internet access and cameras (e.g. 3G phones), e-learning, home security and smart homes, access control, electronic commerce and social networks.

Some examples which illustrate the increase in traffic include:

a) E-mail messages, with 12 billion messages sent in 2000 and 6.1 trillion[11] messages sent in 2009;
b) Google, which in 2000 indexed a billion of pages and around one trillion[12] pages in 2008.

According to global IP traffic forecasts released by Cisco (2008), residential video consumption will be responsible for most of the traffic growth seen between 2007 and 2012.

[7] Video that can be downloaded onto any computer with internet access (saving it, for example, on the hard disk).

[8] Streaming video is a sequence of images transmitted over the Internet in compressed form and displayed on the end-user's monitor. With video streaming, the Internet user does not need to wait for the download of the file to finish before watching the video.

[9] Internet Protocol TV.

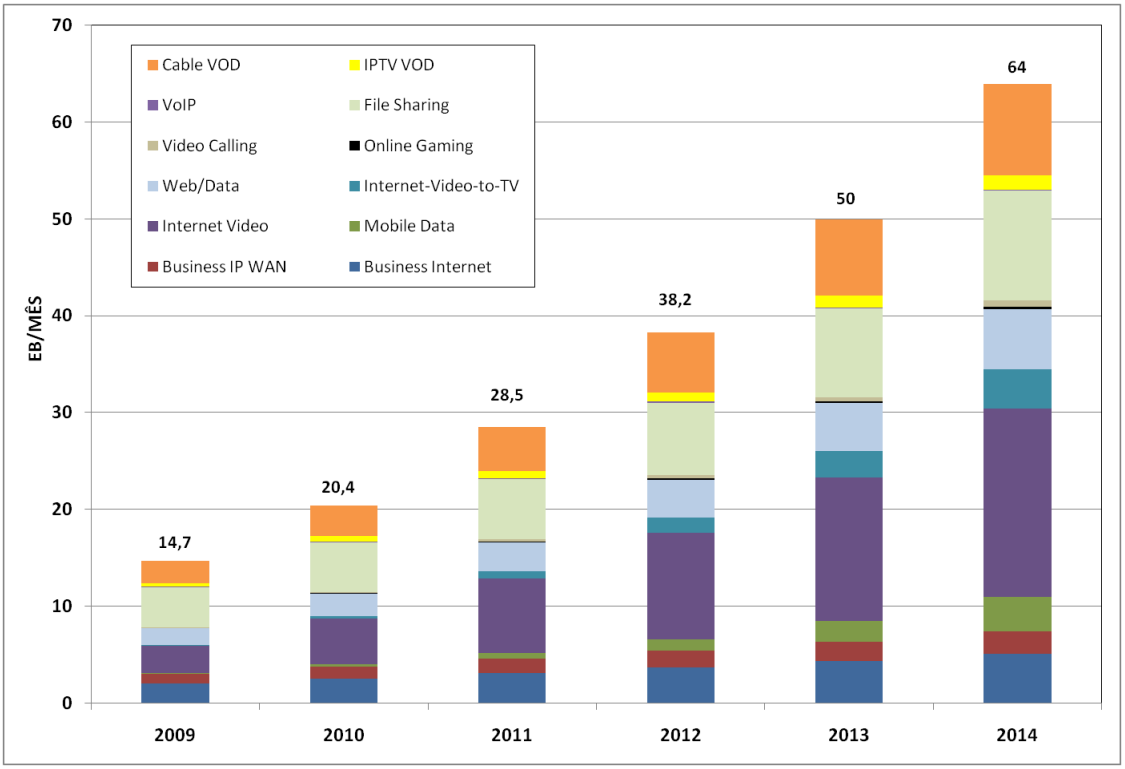
[10] Peer-to-peer traffic represented about 55% of the total volume of IP traffic in southern European countries in 2008/2009 (ipoque, 2009).

[11] 6.1 thousand billion.

[12] One thousand billion

Cisco also sees (see Figure 2) global IP traffic growth of 64 exabytes per month in 2014, with around three quarters of this traffic having residential use. Of the 64 exabytes of traffic generated per month in 2014, around half will be from Internet video applications.

Figure 2 Forecast of Internet traffic consumption per service



Source: Cisco, http://ciscovni.com/vni_forecast/advanced.html

Besides mobile equipment used for mobile communications services, it is expected that in 2010, there were 14 billion network connected devices (in 2000 there were 100 million). Considering the large number of products/objects (environmental sensors, identification chips, applications in food products, post, etc.)[13] where it is possible to place an RFID chip[14], a substantial increase in connections is expected, as well as in data. In coming years, more and more devices will communicate with each other and with humans, creating what is termed the "Internet of Things" (ITU, 2005).

With the possibility that, in the near future, more objects will have real-time monitoring capability and will be connected to networks, and with the widespread adoption of services such as video over Internet, online/virtual reality, IPTV, TV3D[15]/Home Theatre, "Super Hi-

[13] In Portugal, this technology has been widely used in Via Verde.

[14] RFID stands for "*Radio-Frequency IDentification*". It is an automatic identification technology using radio signals, retrieving and storing data remotely using devices called RFID tags.

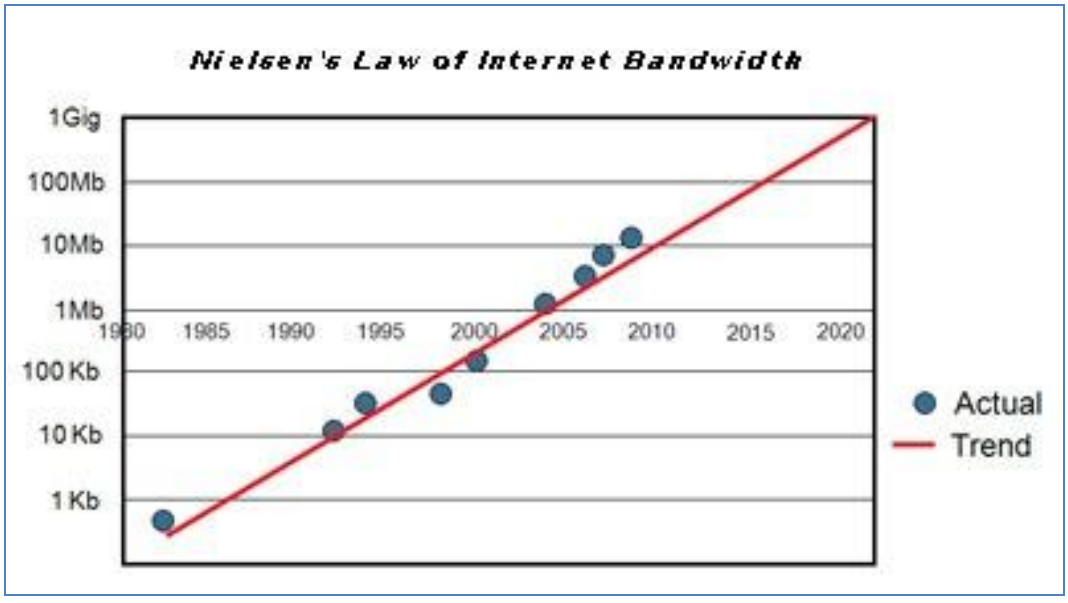
[15] 3D television sets are currently sold around the world (the 2010 football World Cup transmitted in this technology).

Vision"[16], content sharing applications (peer-to-peer), 3G/4G mobile devices, "cloud computing"[17], e-learning, inactivity sensors, online medical consultation, home security, smart homes, access controls, electronic commerce and social networking, traffic values will continue to increase dramatically over current values.

If, when the Internet began, connections with speeds of 56 kbps were sufficient, today new applications and services currently require bandwidths in tens of Mbps, with a clear trend of increased need (at least 100 Mbps in the short term). As such, new access networks with greater capacity (bandwidth) will be required to support the traffic generated and to enable each citizen to take better advantage of existing and future technologies and services.

In 1998, Jakob Nielsen theorized that, for a sophisticated consumer, Internet access bandwidth would have compound growth of 57 times over ten years. Figure 3 shows that this forecast has been adjusted to reality, and has become what is now known (by analogy with "Moore's Law"[18] on the development of integrated circuits) as "Nielsen's Law", suggesting an increase in bandwidth used by a sophisticated user of about 50% per annum.

Figure 3 Nielsen Law's



Source: http://www.useit.com

Also in relation to the evolution in access speeds, in 2006 Heavy Reading made some predictions that are close to the current reality. In **Error! Reference source not found.**4, the

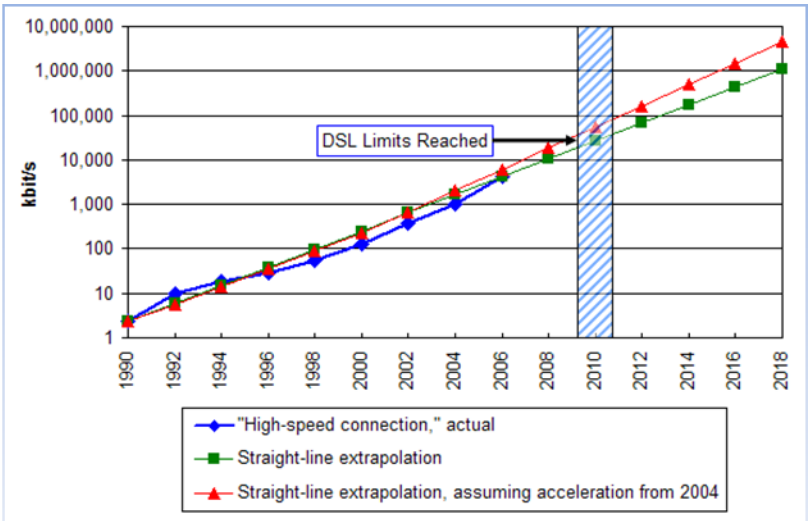
[16] This system, which has been tested jointly by the BBC and NHK in 2008, entails an information density of thirty-two times higher than HDTV, with thirty-three million pixels.

[17] Cloud computing refers to the use of applications residing on remote servers, accessed over the Internet rather than being installed on the user's computer. As such, the functions of management and maintenance, backup procedures or access control, shall be supported by the service provider.

[18] Moore's Law tells us that the processing capacity of chips doubles every 18 months and size decreases at the same rate.

green line extrapolates the historical growth rate with a growth factor of 2.29 per annum, while the red line provides for an acceleration of growth from 2004 to a factor of three per year. It appears that the forecast for 2010 is perfectly in line with the "typical" offers currently being marketed by operators, and that according to this forecast, by 2020, bandwidth per customer will exceed 1 Gbps.

Figure 4 Evolution of the Access Speeds



Source: Heavy Reading, "The Race to the Home: FTTH Technology Options", 2006

Although the forecast according to "Nielsen's Law" is more conservative than Heavy Reading's forecast (pointing to speeds of around 10 Mbps for 2010 while Heavy Reading suggests values of around 50 Mbps)[19], both are clear in the evolution of evolution of speeds over the coming years and suggest a sustained level of growth over the next years.

Given this increased traffic and new and innovative services, a better quality broadband connection becomes a necessity (for example, with a lower contention ratio[20] and latency[21]) providing users with a good experience and allowing them to enjoy all the benefits that these services enable.

Moreover, until recently, the traffic was mostly in the downstream direction (from the network to the user), with upstream speed being of little consequence (having volumes substantially lower than in the downstream direction). However, recently new usage patterns have been reported, in which more and more users send content to each other (e.g. photographs or video) and place their content online to share with others, or for backup, with a tendency for

[19] In Portugal there are already several offers of 100 Mbps and even 200 Mbps for residential customers.

[20] The contention ratio is the value which limits the sharing of the speed of a determined access by various customers and is defined by a parameter (1:k). The speed can be reduced by this effect, in extreme cases by up to 1/K of the contracted speed.

[21] Refers to the time elapsing after a send operation is executed until the data begins to arrive at its destination.

information to be accessible on the Internet from any device/place and at any time, i.e. "it is in the cloud". As such, this new trend is leading to rising demand for higher upload speeds, with a trend towards a narrowing in download/upload speed ratios which also calls for next generation access networks which support this trend.

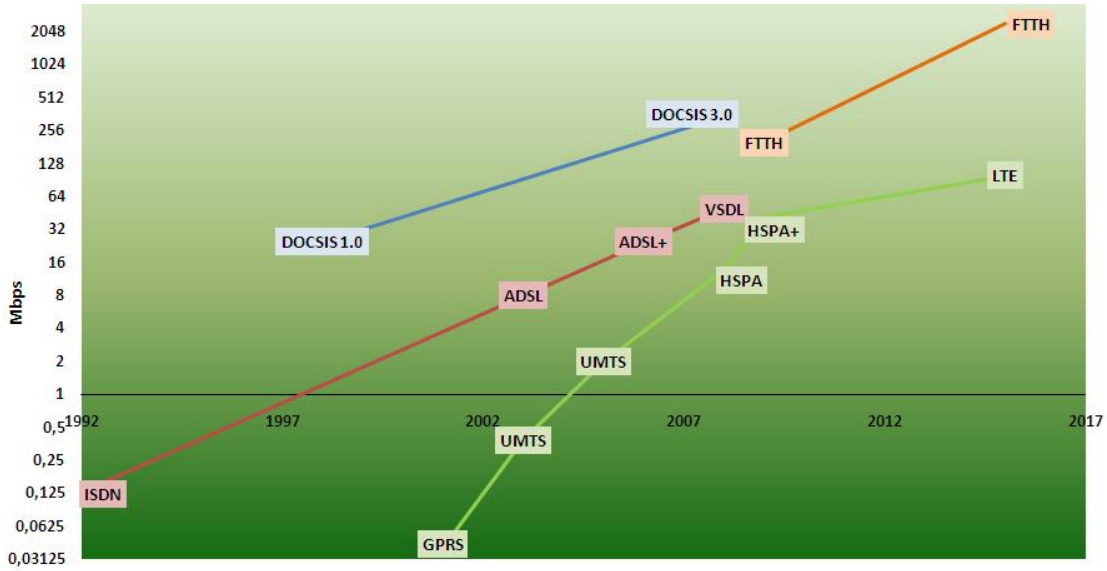
With traffic growing much faster than revenues and faster than the number of customers, operators are faced with having to provide increasingly higher speeds without receiving an effective return on the investments made to support these speeds. To offset this disparity, operators need new services that consumers are willing to pay up for and, for their part, new networks with capacity to support such services (*3Play, QuadPlay*) while enabling significant reduction in the "cost per bit".

It is precisely these new networks - NGN / NGA - which enable these services to be offered without the limitations of previous networks (copper), particularly in terms of bandwidth (in both directions).

3. Access Network Technologies

As mentioned in Chapter 2, traffic continues to increase, leading to the development of new networks (access and switching/core) which can fulfil consumer demands, particularly in terms of bandwidth. The evolution of technologies and the resulting increase in bandwidth made available to consumers began in the early nineties of the last century (with the digitalization of traditional networks and ISDN) - **Error! Reference source not found.** demonstrates this evolution and a possible forecast for 2015. The speeds exemplified are the (current)[22] maximum values achieved in ideal conditions, i.e. good propagation conditions, reduced network load and a low rate of retention. In the case of cable and wireless networks, speeds are shared among multiple users connected to a given "cell".

Figure 5: Evolution in fixed and mobile access networks



Source: ICP-ANACOM

The evolution in access networks in the near future is seen mainly in networks based entirely on optical fibre (e.g. 10G PON, WDM-PON)[23] and mobile networks (LTE), with some optimistic forecasts suggesting that in the future fibre-based networks might provide 10 Gbps and mobile networks 1 Gbps.

Therefore and in order to systematize the information, it was considered that existing access network technologies can be organized primarily into four main groups:

[22] LTE technologies (Long Term Evolution: 4th generation mobile network technology) and FTTH (as well as cable technologies) are still evolving and therefore, in a more distant future, even higher speeds may be attained (especially with FTTH).

[23] Wave Division Multiplexing Passive Optical Network.

c) Wireless (UMTS[24], HSPA[25], LTE, BWA[26], WiMAX[27], Satellite and MMDS[28]);
d) Hybrid fibre-coaxial (HFC);
e) xDSL Technologies[29] twisted metallic pair (includes FTTN/C[30]);
f) Fibre to the end customer FTTH/B/P[31].

Some of the technologies which are comprised by the NGA concept are briefly presented below; especially those which it is considered will see increased deployment to consumers.

3.1 Wireless

Portugal has been a case of success in terms of the penetration of 2G and 3G mobile networks.[32] Mobile broadband is provided primarily over UMTS and more recently and in certain areas, especially in densely populated areas, over HSPA with speeds shared in a cell of up to 14 Mbps and 5.76 Mbps, downstream and upstream respectively. The national mobile operators have launched commercial products based on HSPA+[33], enabling maximum shared speeds of up to 43 Mbps and 11.5 Mbps, downstream and upstream, respectively.[34]

The industry is developing next generation technology, called LTE. This technology could help to achieve shared speeds of around 100 Mbps[35] downstream and 50 Mbps upstream, whereas in 2010 the first deployments were reported[36], although only with data transmission.[37]

Another wireless technology is WiMAX Mobile[38]. This technology, which has had important support from certain equipment manufacturers gave rise to a promise that broadband access

[24] Universal Mobile Telecommunications System (UMTS) - third generation mobile technology adopted in Europe.
[25] High Speed Packet Access.
[26] Broadband Wireless Access.
[27] Worldwide interoperability for microwave access
[28] Microwave Multi-point Distribution Systems.
[29] Digital Subscriber Line: A family of technologies which provide a means of digital data transmission over the twisted metallic pair.
[30] Fibre to the Node/Cabinet.
[31] Fibre To The Home / Fibre To The Building / Fibre To The Premises.
[32] According to the "15th Report on the Implementation of the Telecommunications Regulatory Package - 2008", as at the end of 2009, Portugal was in second place at EU level with regard to the penetration rate of mobile broadband.
[33] Release 8 of HSPA+.
[34] In October 2010, Vodafone began offering access to the Internet with downstream speeds of 43.2 Mbps and monthly charges of 49.99 euros.
[35] Maximum values in optimum conditions, currently almost unachievable in commercial networks.
[36] In early 2010,TeliaSonera launched one of the world's first LTE networks in Oslo and Stockholm.
[37] Efforts are currently being developed to have QoS implemented on LTE networks with a view to supporting voice and other services.
[38] Standard 802.16e.

networks could be installed with lower costs. However, a number of challenges may limit its introduction. These challenges are mainly due to the success of 3G mobile networks and their evolution (HSPA) and current coverage, which has enabled the take-up and expansion of mobile broadband retail offers which already provide similar solutions in terms of speeds.

The advantage of HSPA (3.5G) networks, and in the future, LTE (4G), is that they are considered by owners of 2G or 3G networks as the natural successors of their GSM networks[39], which facilitates adoption and mass roll-out, making it possible for a mobile operator customer to have access to broadband services anywhere in the world (wherever there are HSPA and/or LTE networks). Therefore, new WiMAX networks have the disadvantage that they have to be deployed entirely from scratch; on the other hand, in the case of LTE, required investment is lower and also incremental, since much of the existing infrastructure and systems can be maintained (particularly in terms of switching/core network).

According to the OECD (2010), the question of which of the two systems, LTE or WiMAX, operators will choose depends on several factors such as: a) operational efficiency (e.g. what spectrum resources are available); b) evolution efficiency (e.g. easier migration from an existing system); c) capacity to support the old network (e.g. compatibility with the legacy environment), and; d) economies of scale driven by sales and acceptance in the global market.

The technologies considered as Next Generation Mobile Networks – NGMN (e.g. supported over LTE or WiMAX) will permit the operation of all-IP mobile networks.[40] NGMN differ from traditional mobile networks with their high speeds and lower latency levels and because they support all traffic exclusively through packet-based protocols (IP). The architecture behind NGMN is the IP multimedia subsystem (IMS), which is a 3GPP (Third Generation Partnership Project) standard defined[41] for UMTS/3G networks (but also with deployments at the fixed network level). The IP multimedia subsystem already enables the provision of a variety of services to end-users (wholly) over IP, regardless of the type of access.

Despite possible competition with LTE, WiMAX could become an alternative technology solution for new entrants at a local or regional level, which could offer broadband more economically, given that, in principle, the cost associated with the radio spectrum will be

[39] Global System for Mobile Communications.

[40] All communications will be based on IP packet switching instead of circuit switching as on the traditional telephone network.

[41] In the middle of this decade, starting in 2002: http://www.3gpp.org/ftp/Specs/html-info/23228.htm.

lower than the cost associated with UMTS / LTE[42] or, especially, the cost of developing root access networks of optical fibre (NGA).

Meanwhile, the operators seeking to deploy these technologies are looking carefully at the digital dividend[43] frequencies, given that, according to certain communications sector experts, mobile broadband coverage using the 800MHz band will have a cost around 70% lower than current 3rd generation mobile technology (UMTS), which uses higher frequencies[44].

In this respect, on 06.05.2010, the EC adopted a decision[45] which established harmonised rules for the use of frequencies in the 790-862 MHz band, whereby it sought to give Member States guidance as to the use to be given to the so called "digital dividend", with respect to the spectrum at 800MHz, which is due to be released with the transition from analogue to digital television by the end of 2012. To date, allocation of 800MHz spectrum has been awarded in Germany (April 2010), with auctions also due to take place in Ireland, Norway, Spain, Sweden and France in 2011 and in the United Kingdom[46] in 2012.

3.2 HFC Network

The architecture of HFC networks is constrained by its initial function: the provision, in the early nineties of the twentieth century (in Portugal), of subscription broadcasting services. At that time, optical technology was not as developed and widespread, so the provision of optical fibre to the customer's premises, while technically possible, was not economically feasible. Therefore, the compromise solution consisted of the mixed use of optical fibre cables on the main network and coaxial cable on the secondary network - distribution network - and access network. Such networks are given the generic term "hybrid fibre-coaxial networks *(Hybrid Fibre Coaxial,* HFC), as shown in **Error! Reference source not found.**.

[42] That is, the cost of UMTS licenses, as shown for example in the recent auction conducted by ICP-ANACOM of BWA frequencies, in which two licenses were granted, at a cost of about two million and of about one million two hundred thousand euros.

[43] Additional spectrum which will become available for new Wireless services as a result of the transition from analogue to digital television by the end of 2012.

[44] IP/10/540, http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/540&format=DOC&aged=1&language=PT&guiLanguage=en

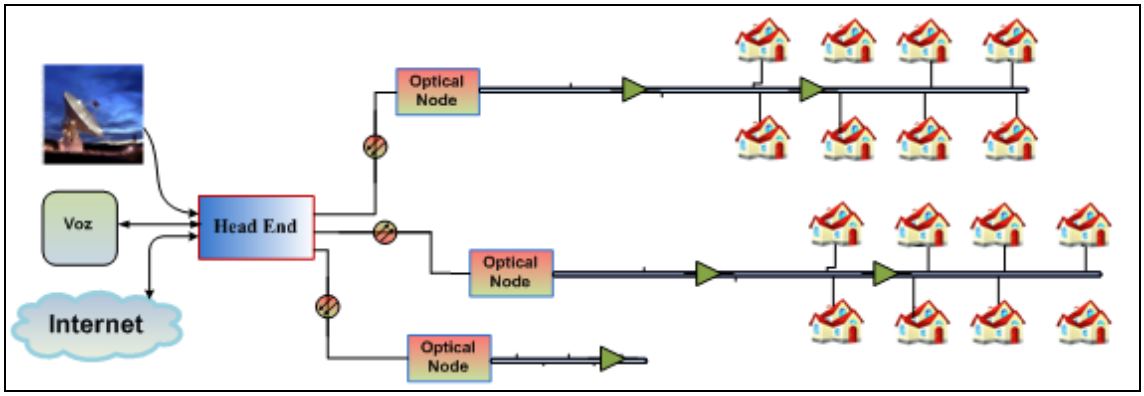
[45] http://www.anacom.pt/render.jsp?contentId=1025103

[46] http://stakeholders.ofcom.org.uk/binaries/consultations/draftap1112/summary/ap201112.pdf

Traditional HFC cable networks use a tree topology with analogue transmission in an RF bandwidth[47] between 50 and 1,000 MHz, serving customers through a shared physical environment. According to ITU-T Rec. J.222.1, it comprises the following characteristics:

a) Transmission in both directions;
b) The maximum optical/electrical distance between the cable modem termination system (CMTS)[48] and the farthest cable modem (CM) is 160 km in each direction, although the maximum typical separation is 15-24 km.

Figure 6 HFC Network



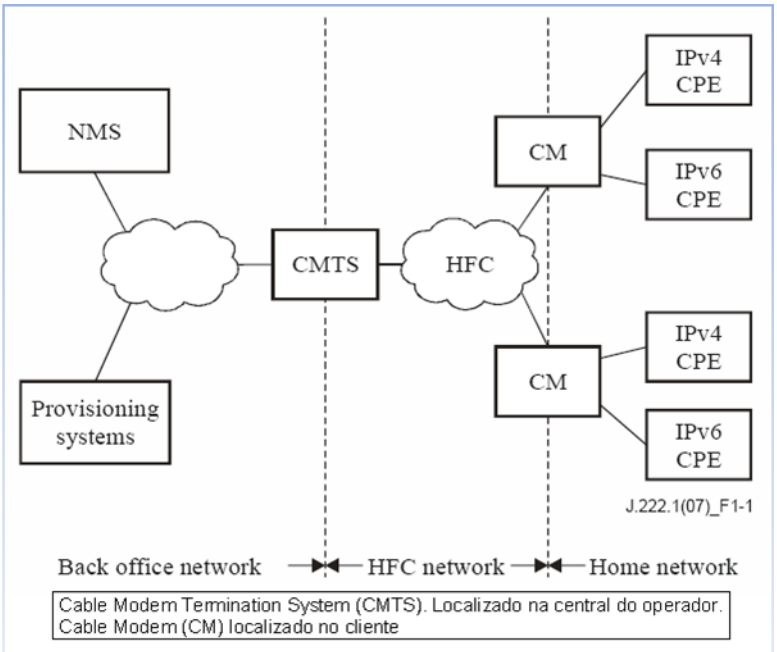
Source: ICP-ANACOM

Enabling increased system speed and reliability, this architecture organizes the cable network in cells of varying size, depending on the demographics of the population served and the expected degree of optical fibre penetration, with each cell connected to the Head End optical fibre, in a star topology. The size of the cells in terms of passed homes is determined, in addition to economic factors, by the maximum bandwidth and the corresponding level of service made available to each customer.

In order to adapt HFC networks to the demand for interactive services, including broadband, and to standardise the offer, in March 1998, the ITU-T adopted the Data Over Cable Service Interface Specification (DOCSIS) as the cable Modem standard (ITU-T Rec. J.112), enabling interoperability and access to data services (see **Error! Reference source not found.***).*

[47] Radio frequency.
[48] Cable Modem Termination System (CMTS), located in the operator's exchange.

Figure 7 DOCSIS network (Transparent bi-directional IP Transport b*etween head end* and the customer)



Source: ITU-T Rec J.112

The initial standard, DOCSIS1.x, assigns a carrier[49] to a set of customers belonging to a cell, enabling downstream (shared) speeds for these customers of up to 50 Mbps. A recent update of the HFC network to DOCSIS 3.0 has enabled maximum shared speeds, for all customers in the cell, to the order of 400 Mbps[50] downstream and 100 Mbps upstream.

This increase in speeds is achieved through the provision of more than one carrier on the access network for transporting data, which has implications for the network's organization and in terms of cable spectrum management. This always implies a reduction in cell size (and consequent increase in their number) in order to provide higher speeds per user, therefore leading to additional investment at network infrastructure level (e.g., more ports at optical node level). Table 1 compares the speeds between DOCSIS 1.x and DOCSIS 3.0, showing that for speeds of 400 Mbps, eight carriers are required.

There may also be a need to reformulate the transport network between the Head End(s) and the optical nodes, so that the network has capacity to fulfil the traffic delivered to and generated by customers.

[49] The carrier is an analogue signal that is modulated (altered) to represent the information being transmitted. The carrier is generally of a higher frequency than the modulating signal (the signal that contains the information).

[50] Assignment of multiple carriers of 50 Mbps to a single client.

Table 1: Maximum speeds[51] for EuroDOCSIS 1.x and 3.0

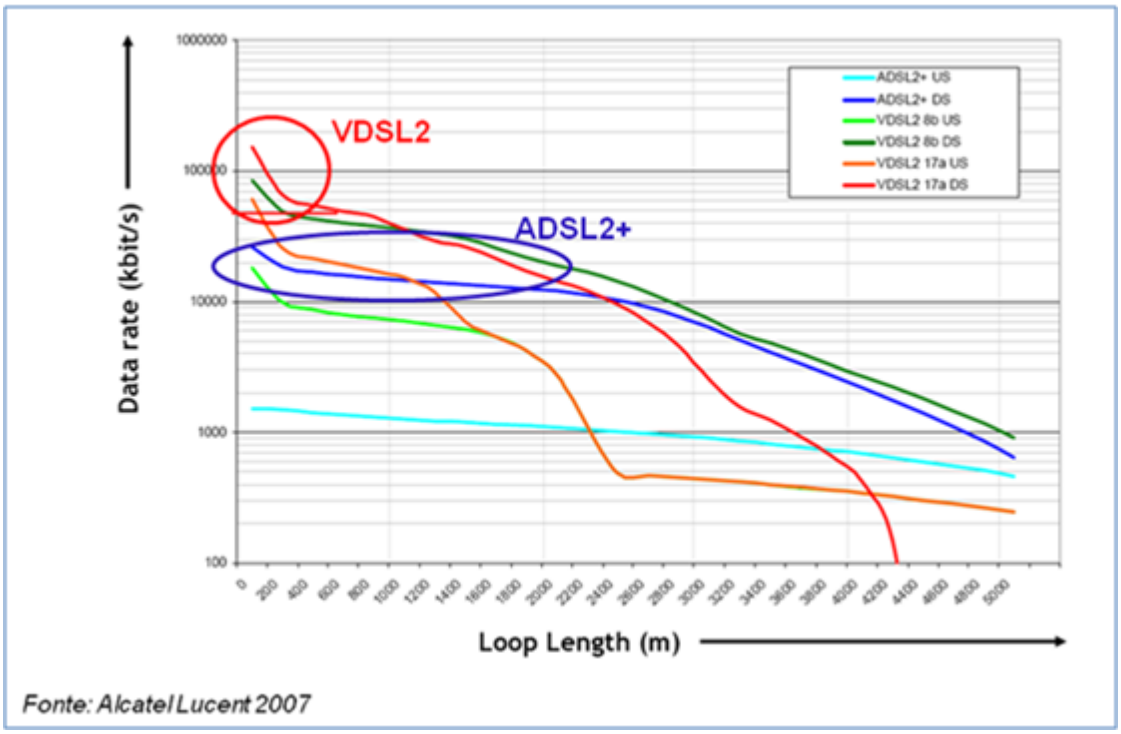
Version	No. of carriers in the downstream direction	No. of carriers in upstream direction	Downstream (Mbps)	Upstream (Mbps)
EuroDOCSIS 1.x	1	1	50	9
EuroDOCSIS 3.0	4	4	200	108
	8	4	400	108

Source: CISCO

3.3 xDSL Technologies

Twisted metallic pairs are still used to transport signals to and from the premises of end-users. As such, the networks based on various DSL technologies are limited in terms of maximum speeds that can be made available, which speeds are severely restricted by the distance (see **Error! Reference source not found.**) between the end-user and the exchange or point of presence.

Figure 8 Data rate versus xDSL distance



Source: Alcatel-Lucent (2007)

ADSL2+ technology allows maximum speeds of up to about 24 Mbps. Of all xDSL technologies, VDSL2[52] (ITU-T G.993.2) allows the highest speeds, up to 100 Mbps at a

[51] Maximum usable transfer rate without overhead.

distance of around 100 meters between the customer and the DSLAM, or typically of 50 Mbps at a few hundred meters. Therefore the DSLAM must be located in a street cabinet.

The adoption of VDSL2 on NGA networks, commonly associated with what is known as FTTC networks (although according to ITU and ERG/BEREC terminology, it known as FTTCab[53]) depends on: (a) technical conditions, such as network architecture, particularly regarding the shorter length of the local sub-loop; (b) economic conditions, since it involves less investment (about 20% compared to FTTH – See Ovum); and (c) demand, as the speed and its evolution is limited.

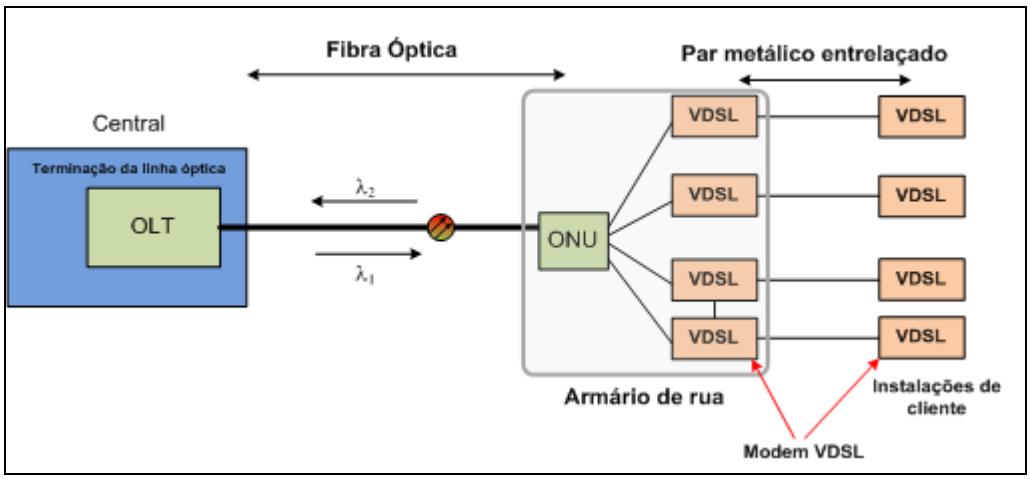
In some countries, e.g. Germany, Belgium and USA, there was an initial focus on the combination of fibre and VDSL/VDSL2 due to factors related to the investment required to support downstream speeds of up to 100 Mbps and the specific network conditions related to the shorter sub-loop (Analysis Mason, 2010; OVUM, 2008), although FTTH is currently being developed (see the cases of Germany and USA in Chapter 3 on the International Scene)

Error! Reference source not found. shows the reference configuration of VDSL2, which is basically an FTTC architecture with one optical network termination (Optical Network Unit, ONU) located in a street cabinet (in the infrastructure supporting the existing copper access network) or in the actual local exchange (with major limitations in terms of length of loops and possible interference with the ADSL2+). For distances under 100 meters, VDSL2 supports (on the 30 MHz channel) maximum downstream speeds to the order of 100 Mbps and upstream speeds of 50 Mbps (maximum theoretical/laboratory).

[52] *Very-high-bit-rate Digital Subscriber Line 2* – is an access technology standard that employs existing copper wire infrastructure which was originally developed for telephone services. It can be provided through telephone exchanges close to customers or buildings.

[53] *Fibre to the Cabinet.*

Figure 9 VDSL network



Source: ICP-ANACOM

According to Alcatel-Lucent, a leading manufacturer of such equipment, VDSL technology can evolve in the short term with respect to speeds or distances, allowing "operators who have invested in FTTC architecture to keep pace with the evolution in demand". Alcatel-Lucent announced[54], in April 2010, that its Bell Labs division had conducted data transfer tests at a speed (downstream) of 300 Mbps over two pairs of copper lines at distances up to 400 meters and a speed of 100 Mbps at a distance of 1 km. This manufacturer expects that this innovation may be available from 2011.

This innovation from Bell Labs consists, in simplified form, in the simultaneous use of two physical copper pairs and a virtual pair (*phantom mode*) in order to triple output. The technological challenges are considerable: first by joining the two pairs, the speed of 100 Mbps in the first pair decreases due to interference or "crosstalk"[55], so that the maximum speed with the two pairs would be around 160 Mbps instead of 200 Mbps. Then a third channel is created, called a virtual channel or *phantom mode*, creating a virtual third copper pair (also subject to and a creator of interference) enabling a maximum of 200 Mbps. To achieve 300 Mbps, the interference problem must be resolved.[56].

In September 2010, Huawei Technologies also announced a new prototype - SuperMIMO DSL - capable of delivering downstream speeds of up to 700 Mbps over connections

[54] http://www.alcatel-lucent.com/wps/portal/!ut/p/kcxml/04_Sj9SPykssy0xPLMnMz0vM0Y_QjzKLd4x3tXDUL8h2VAQAURh_Yw!!?LMSG_CABINET=Docs_and_Resource_Ctr&LMSG_CONTENT_FILE=News_Releases_2010/News_Article_002043.xml

[55] This is when there is interference between the pairs within a cable, that is, the tendency of the signal of a pair of wires to induced by another adjacent pair.

[56] To this end, Alcatel-Lucent uses a technique known as vectorization, in order to cancel out noise and compensate for crosstalk effects. That is, noise conditions on the copper lines are continuously analysed and a new signal is created to cancel out this noise. Therefore, with vectoring, the sum of the three channels (two physical and one virtual), corresponds to the sum of the theoretical maximum speeds associated with a VDSL line - 3 x 100 Mbps.

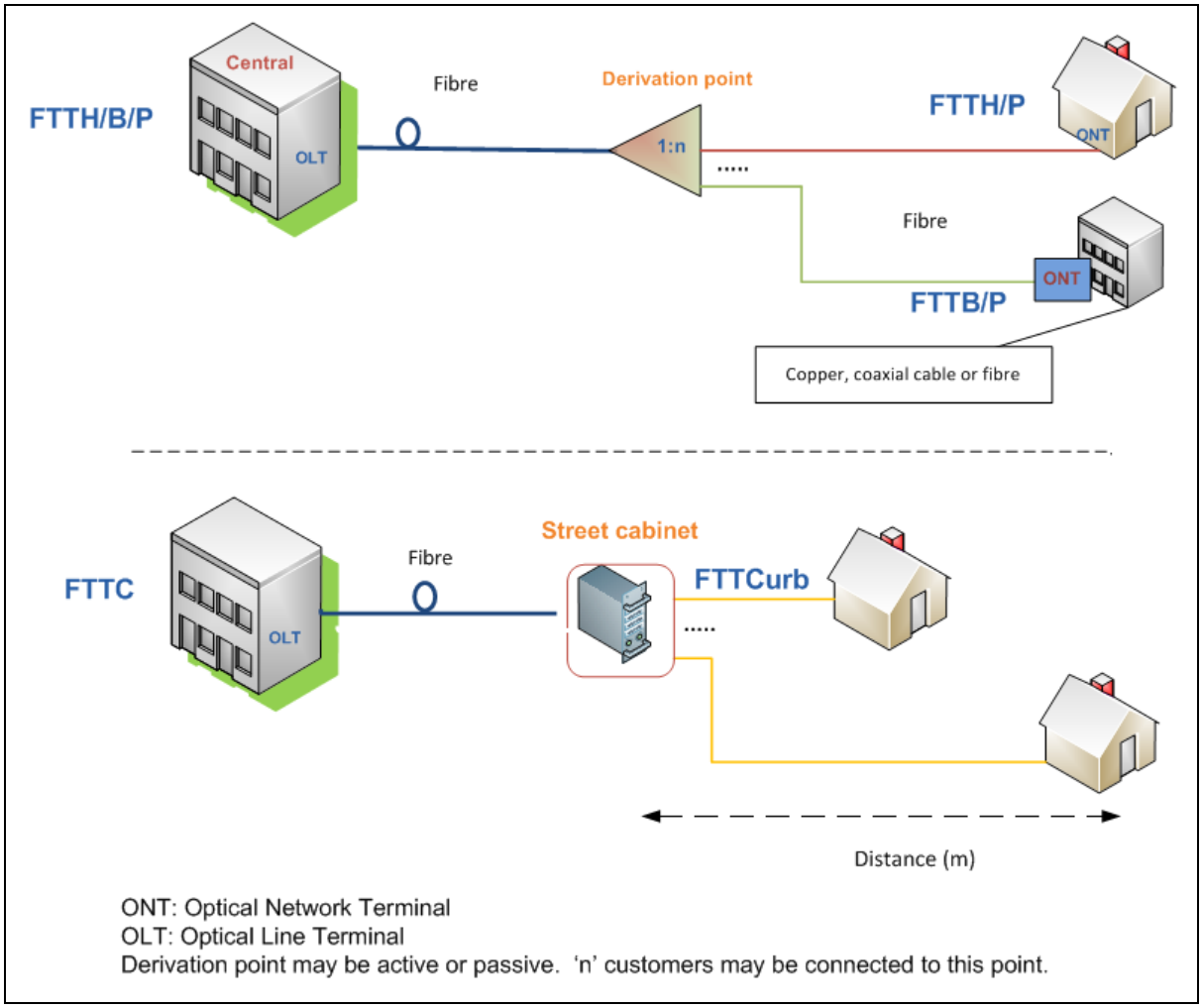
established at a radius of up to 400 meters from the exchange, over four twisted copper pairs. Each pair provides a maximum speed of 175 Mbps, 75% more than the current speed - 100Mbps over VDSL.

This investment in technological innovation using copper infrastructure illustrates its current importance in the provision of communications services.

3.4 FTTH/B/P networks

NGA architectures based almost exclusively on fibre are known as FTTH/B/P: Fibre To The Home / Fibre To The Building / Fibre to the Premises and differ from FTTC: Fibre to Curb / Fibre to the Cabinet (sometimes also referred to as FTTN) and may be characterized according to the siting of the fibre termination point with respect to the end-user (*see* Figure 10).

Figure 10 Structure of FTTH/B/P and FTTC[57]



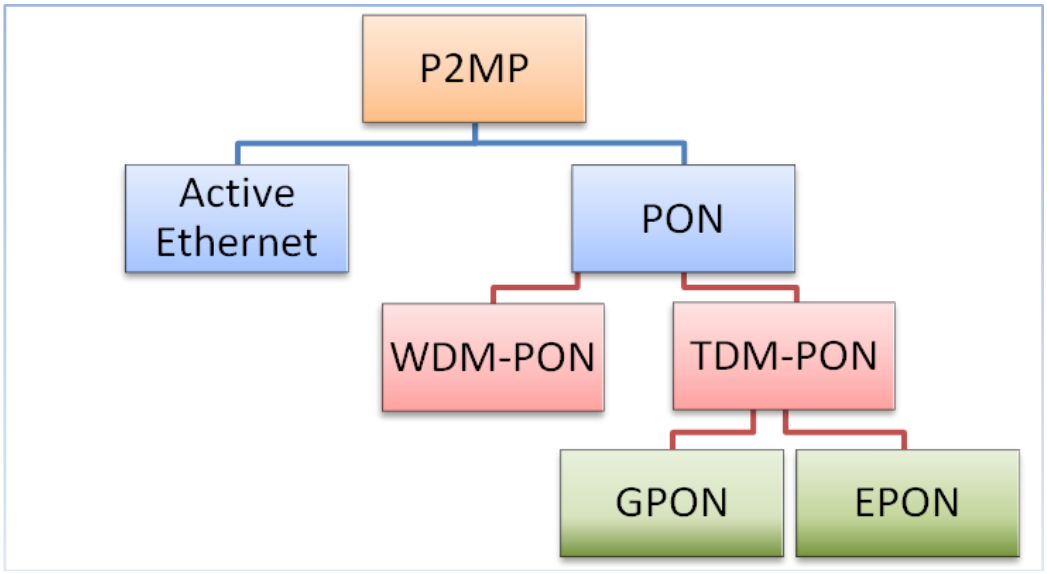
Source: ICP-ANACOM

Given the investments currently underway in Portugal and in various countries, as well as the technological options which, in the near future, appear to give more guarantees in terms of transmission speed evolution, this approach will focus primarily on FTTH architecture. It is noted that FTTC/N architecture with respect to VDSL is addressed in 3.3.

FTTH/B/P networks (including FTTH) can be deployed using point-multipoint or point-to-point architectures. The point-multipoint architecture is subdivided, in terms of potential technologies, into Active *Ethernet* and PON and the latter into TDM/PON and WDM-PON (see Figure 11).

[57] The definition of FTTP in specialist literature is unclear, whereby it sometimes defined as FTTH is considered and otherwise as FTTB.

Figure 11 Architectures and technologies for point-multipoint FTTH Networks

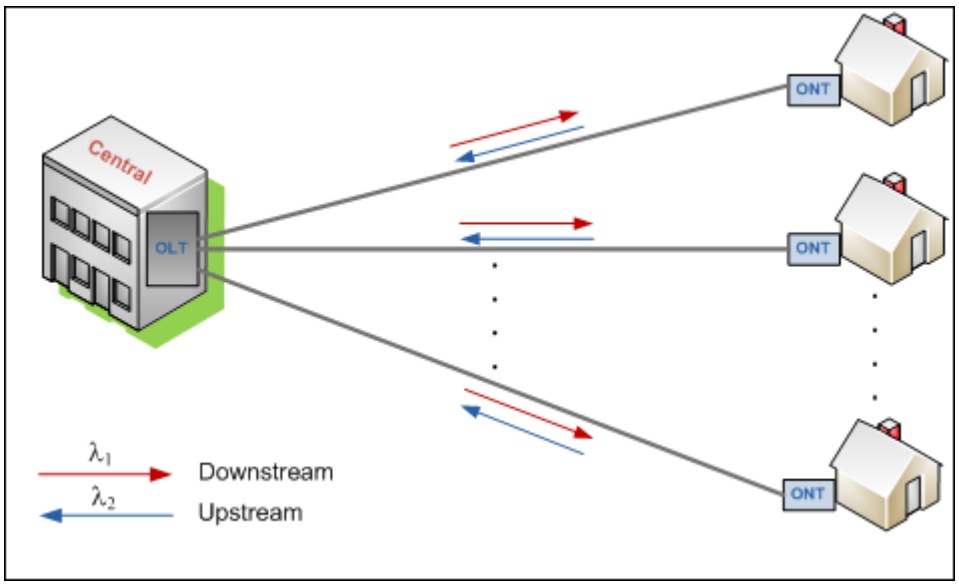


Source: ICP-ANACOM

3.4.1 Point-to-point

Point-to-point architecture is the simplest from a conceptual standpoint. With this architecture, a fibre is installed directly between the customer's premises and the Exchange (*Central Office*/ODF*).* Briefly, point-to-point architecture comprises an OLT port/one fibre per customer, that is, there a laser transmitter and a receiver dedicated to each customer. In this architecture (see Figure 12) all the bandwidth provided by the OLT (on that fibre) is assigned to a single client.

Figure 12 Point-to-point network architecture



Source: ICP-ANACOM

Point-to-point networks allow higher speeds and provision of an improved service, since there is no sharing of the physical environment and, at the same time, they are more flexible since any (substantial) change at the level of supplied speeds only implies the alteration of the active equipment at the two ends of the connection and not of the optical infrastructure. It also means greater security because the dedicated OLT is immune to any disturbance caused by other network users. On the downside, a higher initial investment is required in the installation of additional optical fibre[58], greater occupation of physical space and greater energy consumption in the Exchange because it implies an optical line terminal (laser) per client (OLT).

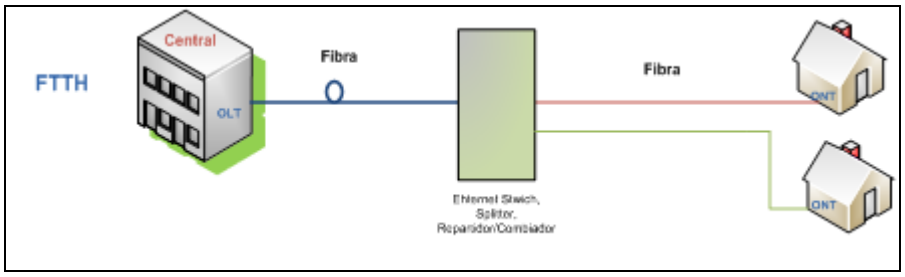
3.4.2 Point-multipoint architecture

Point-multipoint architecture (see Figure 13) has a port on the OLT for each N[59] customers and is subdivided into Active *Ethernet* and PON networks.

[58] According to Alcatel-Lucent and IDATE, this figure could be around 20%, depending on conditions on the ground. If there is shortage of ducts, for example, the price of a point-to-point solution may be much higher.

[59] N, theoretically, can take values between 8 and 128.

Figure 13: Generic point-multipoint architecture

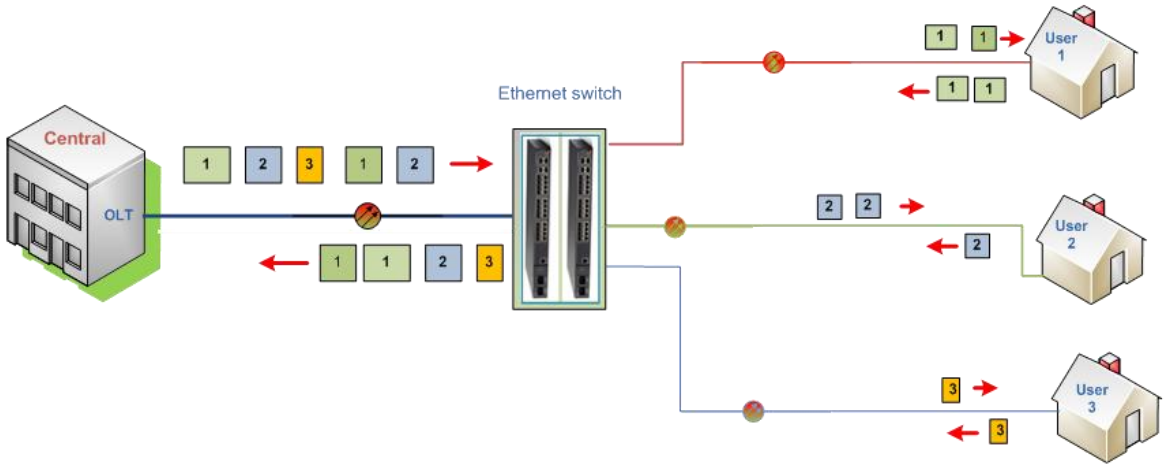


Source: ICP-ANACOM

3.4.2.1 *Active Ethernet*

In active Ethernet architecture, the derivation point is an active node, typically an Ethernet switch, which is used to aggregate traffic from different customers (Optical Network Termination, ONT[60]). Of the different point-multipoint architectures, this requires greater investment in the external network[61], since in order to aggregate fibre connected directly to end-customers, this architecture requires that the Ethernet switches[62] be installed in protected cabinets between the Exchange and the customer's premises, whereas it is necessary to take into account issues related to power supply and temperature control of the active equipment. This is a "layer 2" technology in which the function of the Active Ethernet is to relay to each end-user only the Ethernet frames destined to them, working at a logical level of analogue mode on a point-to-point network (see **Error! Reference source not found.**).

Figure 14 Point-multipoint network *Ethernet* Active



[60] Equipment which terminates the fibre connection which comes from outside and where the customer's private connection begins.

[61] Consisting of all cables, ducts, masts, towers, repeaters and other equipment located between a demarcation point of a switching unit and a demarcation point in another switching centre or customer premises.

[62] The function of the switch, which is an active layer 2 device and commonly used in computer networks, is to relay each of the frames between the OLT and ONT.

Source: ICP-ANACOM

3.4.2.2 PON Architecture

Contrary to *Active Ethernet*, this architecture does not require any electronics (active elements) on the optical network. To share resources it uses passive optical *splitters* in the case of TDM-PON or a splitter/combiner in the case of WDM-PON. The ONT use the same fibre ("feed", linked to the exchange) and the same port on the OLT, making use of multiple access techniques necessary to avoid collisions in the communication between the exchange and end-user. As such, PON networks are divided into TDM-PON[63] and WDM-PON[64] (see Figure 11), with the first operating using time (i.e. two ONT may not transmit at the same time) and the latter operating using wavelength (i.e., each ONT transmits on a different wavelength).

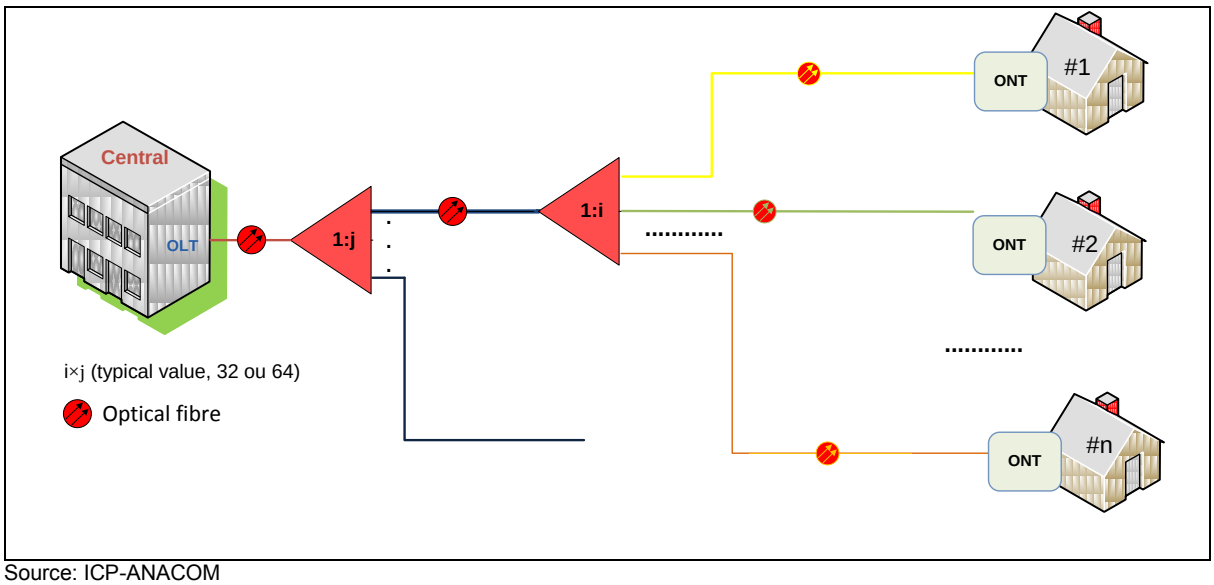
3.4.2.2.1 TDM-PON

As mentioned above, on TDM-PON (EPON or GPON) networks splitters *are used* that: (a) downstream, split the optical signal that reaches the OLT sending it to each ONT and (b) upstream, combine each optical signal with the same wavelength emitted by each ONT into a single beam (see Figure 15). This reduces the cost of aggregation outside the exchange, since the cost of the optical splitter is low and it requires no power supply and little or no maintenance.

[63] *Time-Division Multiplexing Passive Optical Network.*

[64] *Wavelength-Division-Multiplexed Passive Optical Network.*

Figure 15: Generic TDM-PON (GPON or EPON) architecture



Source: ICP-ANACOM

Currently, on TDM-PON networks, the maximum concentration of subscribers per OLT is 64 (in the case of GPON) and maximum distance between active equipment is 20 km. However, at larger distances it corresponds, due to mitigations involved, to a lower concentration, typically 32. On the other hand, the maximum bandwidth provided to users can also determine a lower concentration. Currently, new solutions are under development which will allow greater distances with the same or even higher concentration of subscribers (per OLT and/or splitter).

The most used variants of TDM-PON are GPON[65] (ITU-T G.984.1) and EPON[66] (IEEE 802.3ah). The first operates at an aggregate line speed of 2.5/1.2 Gbps and the second at a symmetrical speed of 1.25/1.25 Gbps. EPON networks[67] were the first to be developed and have a higher prevalence in Japan and South Korea, countries which were first to develop optical fibre networks reaching consumers. GPON[68] networks, which were developed later, are most used in Europe and the USA.

[65] *Gigabit* PON.
[66] *Ethernet Passive Optical Network*.
[67] Standardised in 2004.
[68] Standardised in 2008.

GPON and EPON have different characteristics in relation to the aggregate line rate and efficiency of the TDMA protocol, which is the portion of total speed that can be used for payload. These two technologies also differ in terms of the power budget allowed between the OLT and the ONU, the ratios on the splitters and finally, GPON has a number of advantages due to greater protocol efficiency. Table 2 exemplifies the characteristics of these two architectures.

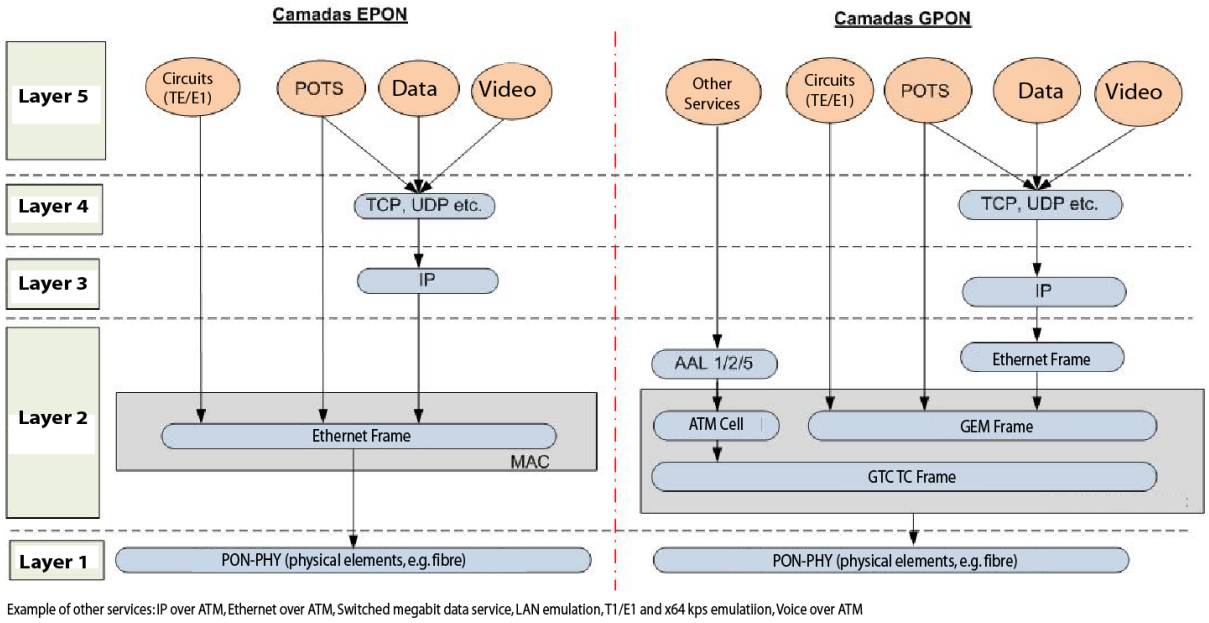
Table 2 GPON vs. EPON

	GPON (ITU-T G984)	EPON (IEEE 802.3ah)
Downstream line speed	2448 Mb/s	1250 Mb/s
Upstream line speed	1244 Mb/s	1250 Mb/s
Maximum derivation	1:64, 1:32 (typical)	1:32, 1:16 (typical)
Maximum range	20 Km	20 Km
Average Efficiency[69] (ε)	≈ 93%	≈ 65-70%
Traffic supported	Ethernet, ATM, SDH	Ethernet

Source: ICP-ANACOM

At the technological level the most obvious difference between these two network types is the architectural approach at Layer 2 level (see Figure 16). GPON (with three sub-layers in Layer 2) offers different types of traffic, such as: IP on Fast, Gigabit, or 10 Gbit Ethernet; TDM over SDH interfaces; and ATM between 155-622 Mbps. EPON, meanwhile, employs a single level 2 Layer that only uses Ethernet for transporting data, voice and video.

Figure 16: EPON vs. GPON Layers

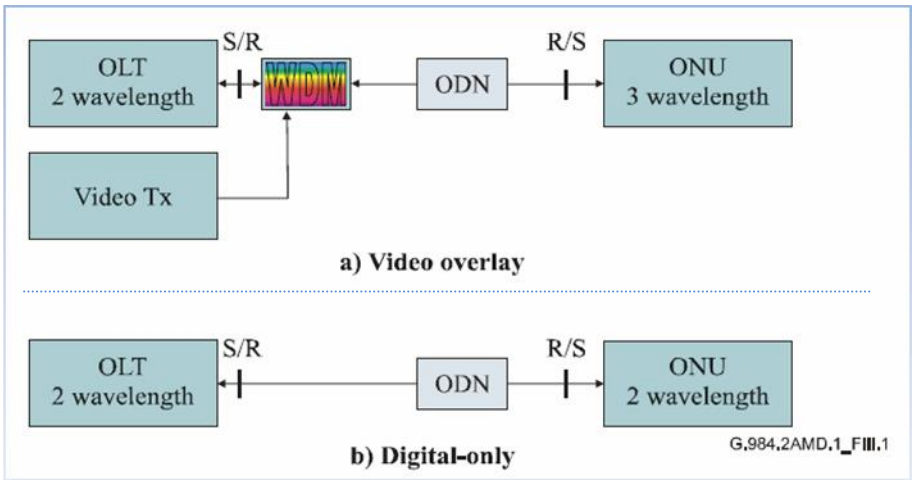


Source: ICP-ANACOM

[69] Efficiency refers to the proportion of speed used for data transport.

Regarding GPON (see Figure 17), data is extracted at the ONT (e.g. Ethernet and ATM) and according to ITU-T G.984.2, there is currently the possibility of using a third wavelength to introduce additional services - typically television/video, called *RF Overlay*[70].

Figure 17 GPON applications - with or without *overlay*

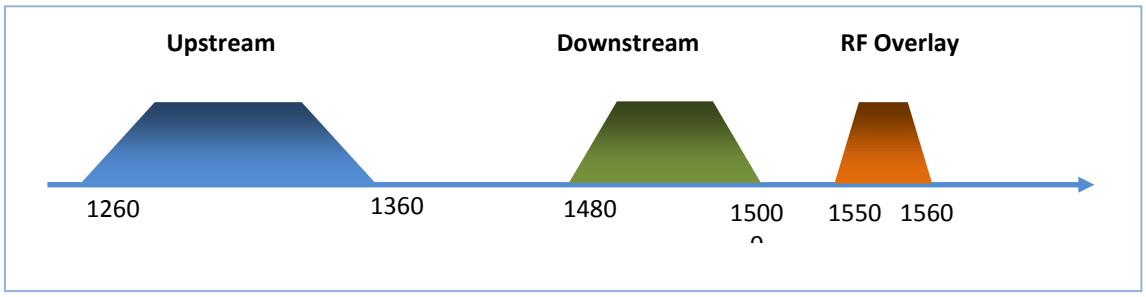


Source: ITU-T G.984.2

Figure 17 corresponds to a complete system service with overlapping analogue video through *RF Overlay* using a third wavelength multiplexed with the optical signal which transports data so that the TV signal is transmitted over the same optical fibre. Figure 17 represents a fully digital system in which video, is broadcast on IPTV, using only two wavelengths.

Error! Reference source not found. exemplifies how the spectrum for GPON is organized to support the two situations described above.

Figure 18 GPON Spectrum



Source: ICP-ANACOM

[70] *Radio Frequency (RF) Overlay* consists of the transmission over a optical fibre of the analogue video signal at a wavelength different from those used for sending data. At the client's home, the optical signal is converted into RF and can therefore be distributed to all reception devices without requiring decoders.

In the system with *RF Overlay*, the terminal equipment converts the optical signal into an electrical signal by separating the digital signals (data and digital video) and analogue video. The latter can be inserted into the existing coaxial network in every room of a house without additional decoding and so without need to use a *set-top box*[71].

The EPON variant (IEEE 802.3ah) of the passive optical network is based, as mentioned above, only on Ethernet technology, which is why it is called an EPON network (Ethernet PON). On this type of networks, the OLT is an Ethernet switch, which transmits, in the downstream direction, Ethernet frames which pass through a splitter (1:n) and are delivered to each ONT, which selects the frame meant for it from among all the frames. In the upstream direction, the problem of access/collision needs to be considered; that is, two frames simultaneously arriving at the OLT may collide. To overcome this problem the ONT are synchronized based on a TDMA scheme (Time Division Multiple Access), whereby a time slot with capacity for the transport of several Ethernet frames is allocated to each ONT.

These two architectures, GPON and EPON are evolving, and within a few years are expected to evolve into 10G-GPON[72] and 10G-EPON, with substantial improvements in performance, and allowing downstream speeds of 10 Gbps. Indeed, in September 2009, the IEEE 802.3av standard for 10G-EPON was completed, with two configurations supporting this technology: symmetric, operating at speeds of 10 Gbps, and asymmetric, with 10 Gbps downstream and 1 Gbps upstream.

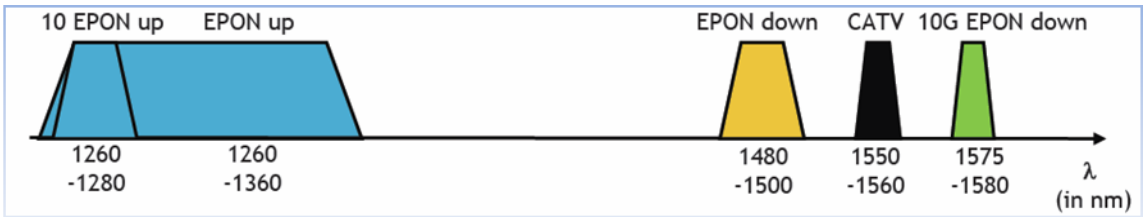
In terms of compatibility with current systems, EPON requires the management of the optical spectrum allocation, since the upstream bandwidth of 10G-EPON coincides with that of EPON (see Figure 19).

Therefore, to ensure compatibility of the two systems on the same optical fibre, the OLT will have to use wavelength division multiplexing to transmit data downstream, meaning that, upon the introduction of 10G-EPON, it will have to be replaced by one that supports all wavelengths and that is capable of differentiating upstream traffic. As such, this technology does not allow for gradual evolution, since it requires a complete alteration of the OLT, unlike with GPON.

[71] A term that describes a device which, in its simplest form, is connected to a television set and an external signal source and converts this signal into content in a format that can be shown on that television.

[72] Portugal Telecom began testing this technology in October 2010.

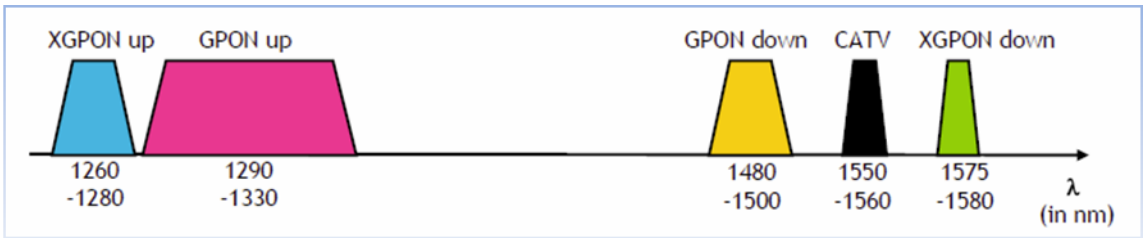
Figure 19 Spectrum allocation for co-existence between EPON and 10G-EPON



Source: Alcatel Lucent

In the case of GPON, since different wavelengths are used without overlapping of bandwidth, it is simple on the reception side to separate the wavelengths for GPON and 10G GPON (see **Error! Reference source not found.** and Figure 21) so that the two solutions can coexist on the same network. In both situations, RF Overlay remains possible, since the video signal is transmitted with a 1555 nm wavelength[73]. Upon introduction of 10G GPON, it is necessary to introduce new emission equipment and to multiplex the WDM signal through the signal of GPON in the exchange. It is noted that 10G GPON technology was standardised[74] by the ITU-T in October 2010.

Figure 20 Spectrum allocation for co-existence between GPON and 10G GPON

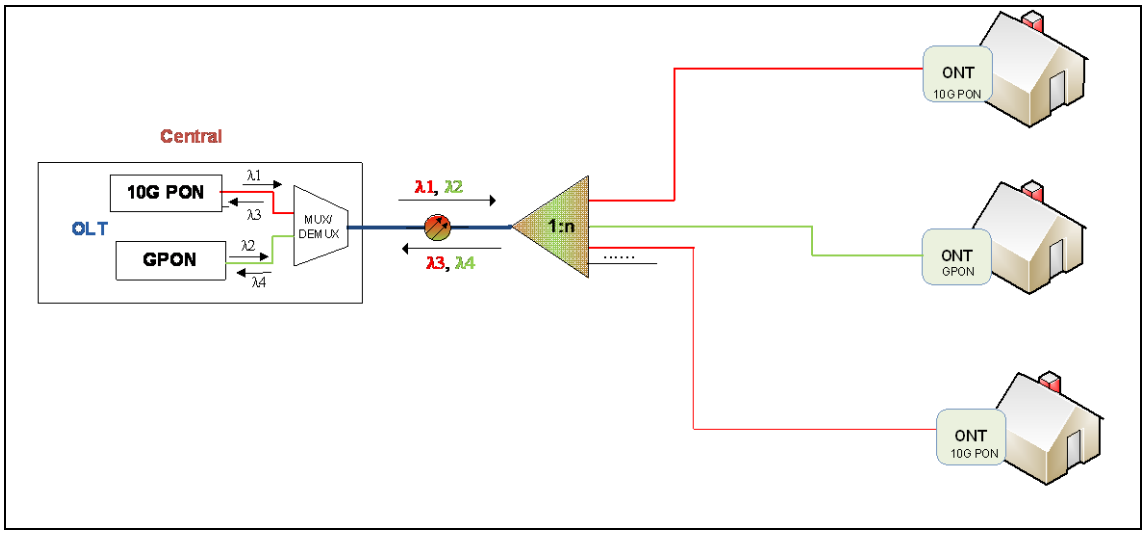


Source: Alcatel Lucent

[73] Length Unit of the International System, commonly used for measuring wavelengths of visible light, ultraviolet radiation, infrared radiation and gamma radiation. A nanometre is a subunit of meters, corresponding to 1.0 × 10 metres.

[74] Recommendation G.987.3.

Figure 21: Compatibility between PON and 10G GPON



Source: ICP-ANACOM

3.4.2.2.2 WDM-PON

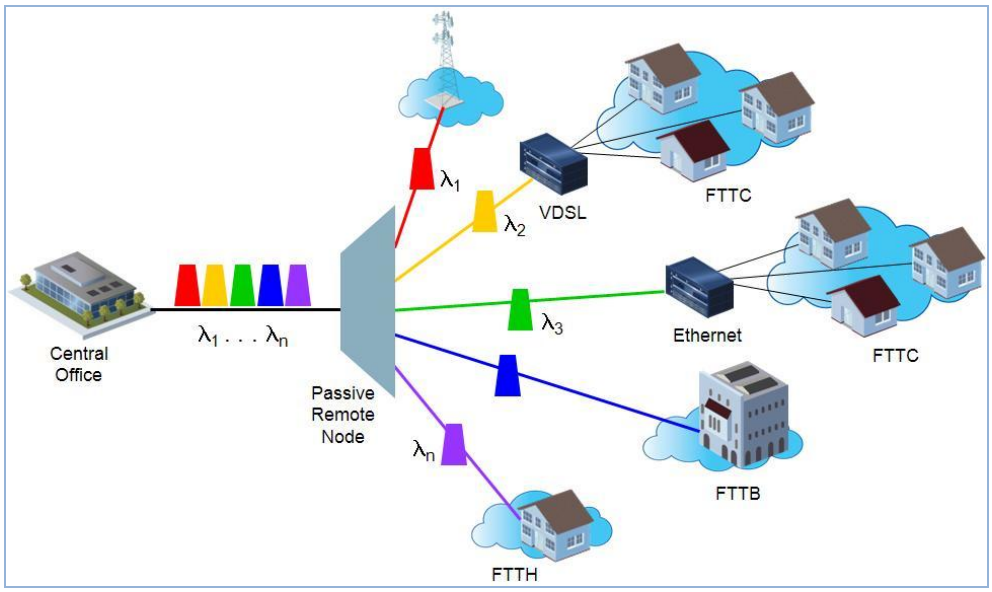
Another PON technology, currently undergoing definition at the level of standardization[75], is WDM-PON, which supports various wavelengths and can therefore be used as a point-to-point network (one wavelength per customer) or as a point-to-multipoint network with several operators using the same network (one wavelength per operator – WDM GPON network) so that each one uses the network as if it were an actual GPON. *See* in this regard the following section.

WDM-PON networks are subdivided into CWDM (Coarse-WDM)[76] and DWDM (Dense-WDM)[77]. It is expected that up to 40 or more customers are served by a single access fibre in the DWDM variant and 8 in the CWDM variant.

The physical topology of WDM-PON (see Figure 22) is similar to that of EPON and GPON, but there are some differences in the distribution node. In the case of DWDM, this network point consists of a splitter together with a combiner, which combines optical signals from each ONT into just one and sends it to the OLT, and a (de)multiplexer known as Arrayed WaveGuide (AWG) which forwards the different wavelengths to the different ONT. In the case of CDWM, the distribution point consists of a range of WDM equipment and CWDM (de)multiplexers.

[75] http://www.itu.int/ITU-T/studygroups/com15/sg15-q6.html.
[76] Coarse wavelength division multiplexing.
[77] Dense wavelength division multiplexing.

Figure 22 WDM PON network



Source: FTTxtra

This technology supports any service (Ethernet, TDM[78], ATM, etc.) in transparent from and at very high speeds per wavelength (currently up to 10 Gbps) in a logical point-to-point topology. The fact that each ONT works with wavelengths which are different from the others, thereby referred to as "coloured" ONT, makes the deployment of such networks more complex since the ONT wavelengths are different from each other, which is a disadvantage over TDM-PON, where all the ONT use the same wavelength for transmission and reception.

The solution to this problem would be to use *colourless* ONT, which are more complex and more costly. There is currently only one supplier known to offer this type of equipment.[79] Very simply, this solution functions by transmitting all the signals as one to the distribution point. To this end, a signal is generated with very wide bandwidth on the OLT which contains all the wavelengths to be transmitted and which will be filtered by the AWG and divided into *n* "slices" that are sent individually to each of the *n* ONT.

WDM-PON technology is not yet standardized or adopted, for reasons related to the technological challenges, since the OLT requires a set of lasers (one per wavelength), which has implications in terms of costs. Apart from these aspects, the acquisition of an AWG should involve greater investment than required for the splitters used in a traditional PON (e.g. GPON).

[78] *Time Division Multiplexing.*

[79] http://www.nortel.com/products/01/ethernet_access/nn123922.pdf.

CWDM is a low density WDM technology in terms of wavelengths. In this technique, information is grouped according to Rec. ITU-T G.694.2, into 18 channels in the 1271 nm to 1611 nm band, with a distance of 20 nm between channels.

Currently the most used frequency bands in CWDM systems are:

a) Band O (*Original Band*) – from 1260 nm to 1360 nm;
b) Band E (*Extended Band*) – from 1360 nm to 1460 nm;
c) Band C (*Conventional Band*) – from 1530 nm to 1570 nm.

DWDM technology (ITU-T Rec. G.694.1) differs in the number of CWDM wavelengths transmitted, which is much larger, with smaller spacing between them. Currently, these systems can use up to 80 channels (wavelengths); this number may increase further in the future. For example, to have a bandwidth of 500 Gbps, a DWDM system can support 50 wavelengths, each transmitting at 10 Gbps. However, given the complexity of the technology, and because it requires very precise lasers and filters, it is not yet in use in the access network.

Currently, the frequency bands most used in most DWDM systems are:

a) Band S (*Short Band*) - from 1450 nm to 1500 nm;
b) Band C (*Conventional Band*) - from 1530 nm to 1570 nm;
c) Band L (*Long Band*) - from 1570 nm to 1625 nm.

Table 3 summarises the differences between these two technologies, showing the advantages and disadvantages of each.

Table 3 CDWM vs. DWDM

	Advantages	Disadvantages
CWDM	• Reduced power consumption (-20%) • Needs less space (-30%) • SMF cable can be used[80] or MMF[81] • Can use LEDs or Laser • Large data capacity per channel • Small and economic filters • Cost savings in the instigation and expansion of the network	• Smaller capacity than DWDM • Lower range • Signal regeneration
DWDM	• Maximum available capacity • Greater distance with EDFA[82] • Easy integration of optical amplification • Supports very high speeds per ONT (up to 10Gbps • Over 80 channels	• Complex technology requires: • More space • More power • Very precise lasers and filters • Very expensive EDFA amplifiers • The setup costs are higher than for CWDM

Source: ICP-ANACOM

The introduction of WDM-PON networks can coexist with previously installed GPON networks allowing specific wavelength allocation to a network or, at most, to an individual customer.

3.5 Access to network elements

The obligation of access to network elements or to electronic communications infrastructure is applied to the historic operators due to the existence of significant market power (SMP), and to the provision of the part of its access infrastructure to alternative operators according to regulated conditions.

The first broadband access wholesale offers comprised bitstream access and the local loop unbundling offer (LLU). The first was deployed by PT Comunicações (PTC) in a first phase almost a decade ago through the mandatory existence of a wholesale bitstream access offer

[80] *Single-mode optical fibre.*
[81] *Multimode fibre.*
[82] *Erbium Doped Fibre Amplifier.*

whenever there was an offer at retail level, given the obligations of non-discrimination. The second was introduced, in full access and shared access models, from the beginning of 2001.[83]

There are two LLU models: full access and shared access. In the first solution, the OAO have complete control over the copper pair of the historic operator. In the second option, the narrowband is separated from the broadband can may be provided by the historic operator to OAO. In any case, the OAO control their co-located equipment[84] in the historic operator's exchange.

Since liberalization, the OAO have faced various challenges related to "horizontal barriers" (in particular regarding access to ducts, since the historic operator had the majority of ducts in its possession) and "vertical barriers" (since the historic operator was present in most buildings), making it necessary to create conditions enabling the sharing of ducts with alternative operators. The operators supported by HFC already had access to ducts needed to establish their network.

As such, with the aim, *inter alia,* of creating mechanisms that facilitate access to the historic operator's ducts, the Electronic Communications Law (Law no. 5 / 2004 of 10 February) was enacted and it was further determined in 2004 that the Reference Duct Access Offer (RDAO) be established, introducing greater transparency in the negotiation of access and related services in the passage of cable in ducts (this matter is developed in Chapter 6 of this document).

With respect to the reduction of vertical and horizontal barriers, in November 2009, ICP-ANACOM approved the new versions of technical manuals named ITED Manual[85] and ITUR Manual[86] so that these also include optical fibre solutions that are expected to assume an important role in the future. This matter is developed in subchapter 5.2.5 of this document.

Notwithstanding the relevant market analysis, which this document does not address, it is important to verify the feasibility of access to networks or services in an NGA context.

[83] With the introduction of Regulation (EC) No. 2887/2000 of the European Parliament and the Council of 18 December 2000 on unbundled access to the local loop.

[84] DSLAM Splitter, filter.

[85] http://www.anacom.pt/streaming/manual_ited_2.pdf?contentId=995812&field=ATTACHED_FILE.

[86] http://www.anacom.pt/streaming/manual_ITUR1edicao_Novembro2009.pdf?contentId=995810&field=ATTACHED_FILE.

3.5.1 Access to cable networks

Experience regarding cable network access is scarce, however, at an international level, a wholesale offer is identified of broadband access supported over HFC network. This is the case in Denmark where the decision of the Danish regulator, the National IT and Telecom Agency (NITA), was recently imposed in respect of the cable network of the historic operator. Also in the Netherlands, the cable operator Ziggo has a wholesale television offer.

The cable network operators have argued, in the consultation conducted by the ERG in 2005 on wholesale broadband access via cable[87], that the means of local access (from the end-customer to the CMTS on a cable network) is shared, while with DSL technology (from the end-customer to the DSLAM) it is dedicated, and therefore the overall capacity of the cable network is more limited. They further argued that access through the layer 3 would undermine the differentiation of services.

In Denmark, where the historic operator, TDC, is in possession of the copper network and is the country's largest cable network, the Danish regulator, in its analysis of Market 5, concluded in particular that TDC had no economic incentive to build two parallel infrastructures in a given area and that, from a purely economic standpoint, it only had incentive to undertake a modernization of the copper access network where it was unable to provide the service over the cable network.

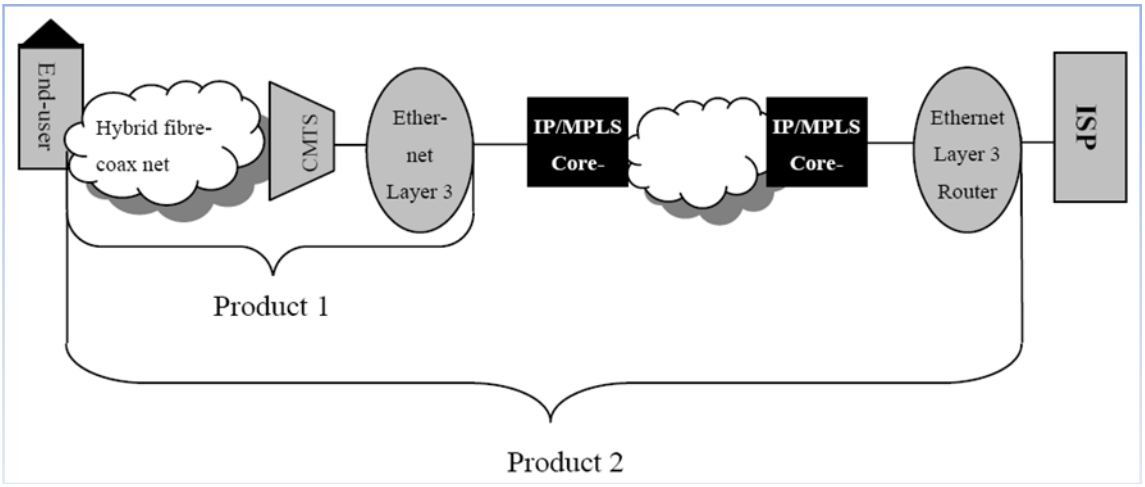
Therefore, in areas where TDC does not improve the copper access network and where it already has access through the cable network, wholesale customers do not have the ability to compete in the broadband (high-speed) segment, leading to a competitive advantage for TDC and allowing the company to maintain its market position.

To address the competition problems identified in the analysis of the market and ensure a technologically neutral regulation, in December 2009, following the market analysis, NTA established the obligation of wholesale provision on the historic operator's network cable. The solution found (see Figure 23) for shared access to the cable network was based on defining two products:

a) Product 1: Wholesale access is performed at the level of layer 3 Ethernet switch (router/*switch*) closest to the end-customer, or equivalent point;
b) Product 2: Wholesale access is performed at the level of level 3 Ethernet switch or equivalent point in a location which is more central than the previous solution, including if necessary transport over IP/MPLS.

[87] ERG (05) 24 - *Summary of the consultation on wholesale broadband access via cable*

Figure 23: Illustration of the scope of the two products of broadband access on the cable network



Source: NITA

3.5.2 Access in architectures (FTTH)

This subchapter is mainly focused on point-multipoint FTTH, given that most of today's networks are based on this architecture. However, with regard to point-to-point networks, from a technical point of view, access could comprise, for example, the simple unbundling of fibre, in line with the Local Loop Unbundling Offer.

The deployment of networks with point-multipoint architecture (e.g. GPON), due to their characteristics of physical sharing of electronic communication resources between end-users, raises the question of the feasibility of sharing between network operators. In addition to the sharing of unused passive resources, as may be the case with the provision of "*dark fibre*", recent deployments lead to the conclusion that sharing through bitstream *access* is viable in respect of FTTH solutions.

3.5.2.1 Bitstream access

In an FTTH GPON solution, wholesale bitstream access, where feasible, may give rise to interesting questions depending on the competitive conditions and conditions of supply and demand. An example is the conditions of the wholesale broadband supply for Internet access. The wholesale offer could be defined starting at IP level (Layer 3)[88], in line, for example, with what happens now in the basic "Rede ADSL PT" offer - wholesale reference offer[89] of PTC providing access to this operator's ADSL2+ network -, compromising to some degree the flexibility of the offers, since it would be difficult to define QoS for each operator;

[88] Of the OSI - "Open Systems Interconnection" model. The purpose of this reference model, which is an international standard, is to provide a common basis for coordinating the development of standards for the interconnection of systems, while also ensuring continuity through the consideration of current systems, giving them a framework in the reference model.

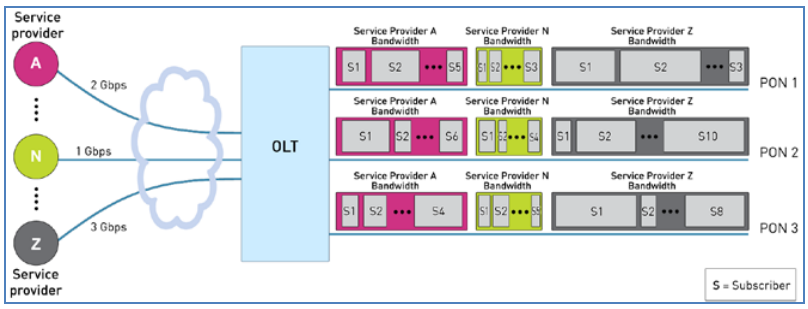
[89] http://www.anacom.pt/render.jsp?categoryId=211722.

otherwise a connection to the network could be defined at an aggregation point, whereby the traffic is delivered on the network and to customers using an Ethernet-based solution (layer 2), also an option already provided for in the offer mentioned above.

As such, the network of the wholesale provider would need capacity in terms of equipment located in the Exchange, or at an aggregation point higher in the hierarchy, to support the connection of multiple service providers. This solution, however, would not, from the outset, cover TV broadcasting with *RF Overlay,* since this broadcasting signal (analogue) is currently multiplexed without addressing at a later stage, thereby dispensing with logic processing in its extraction at the level of the end-customer. Therefore, a TV signal, shared by several operators would have to be processed and distributed as IPTV.

The solution of wholesale access at Ethernet level was adopted by applicants to the NGN tenders in rural areas[90] and implies that the wholesale network operator allocates the available bandwidth (corresponding to 1.25 Gbps upstream and 2.5 Gbps downstream) per OLT in virtual channels (VLAN)[91], allocating different channels/VLAN to different operators (see Figure 24); as such, there is still flexibility to adjust the allocated bandwidth, according to the needs of each operator,.

Figure 24 *Bitstream*



ECI(2009)

It is noted that this type of solution (VLAN) has been adopted in the Next Generation National Broadband Network of Singapore, in Australia (NBN network) and is being tested in the United Kingdom (see case studies below relating to these countries).

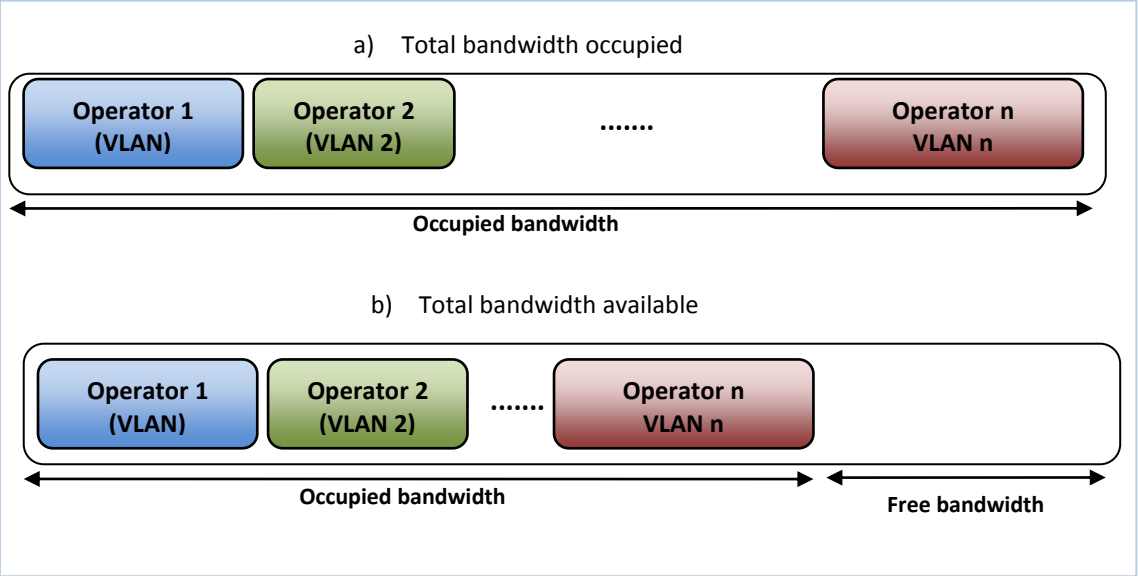
However, the question of how the bandwidth will be divided among the various operators is still not clear, or if it will be allocated according to the needs of the operator (e.g. number of customers, type of service) or one will be assigned a single value.

[90] http://www.anacom.pt/render.jsp?contentId=1009807.

[91] Virtual LAN. Virtual local access network.

The implementation of this bitstream solution on a GPON network, could, at the limit, if the adoption of retail services at NGA was significantly rapid and widespread, place constraints on the evolution of offers of retail operators in terms of bandwidth (speeds) available where the wholesale supplier lacks the capacity to increase the bandwidth allocated to each of the service providers. This could happen if the bandwidth was fully allocated (Figure 25a) to VLANs (to retail operator(s)), as opposed to a situation where the management of bandwidth by the wholesale operator requires some capacity to be reserved to ensure that operators will be able to increase bandwidth in the future according to their needs, or to enable the entry of a new operator (Figure 25b).

Figure 25 Bandwidth for multiple VLAN



Source: ICP-ANACOM

In any case, in line with the evolution in demand, GPON networks will surely evolve in terms of increasing bandwidth, for example with the introduction of 10GPON (see section 3.4.1.2.1), which may overcome any constraints.

The issue of access to NGA networks has also seen, as mentioned above, some development in the United Kingdom, including with the proposal for a standardized interface and the definition of the wholesale offer for local access using the NGA network of the historic operator (British Telecom, BT) in areas with market failures and which Ofcom designates as Virtual Unbundled Local Access (VULA). VULA therefore corresponds to a virtual connection of an alternative operator between the local exchange and each household. However, the question of constraints on the evolution/sharing of speeds was not addressed by that regulator.

In October 2010, Ofcom (2010c) published the report of the public consultation on the obligations to be applied to operators with SMP on the "wholesale local access market". This report sets out the new regulatory model based on the following elements: LLU, VULA and Physical Infrastructure Access (PIA). Ofcom expects that the two new regulatory remedies, VULA and PIA, will be used in different circumstances: a) VULA, is likely to be more attractive for use in areas where BT has modernized its local access network; b) PIA will be attractive for companies that want to take advantage of market opportunities before BT, and may be of particular interest to companies wishing to provide services in areas that may come to have some kind of public funding.

VULA will therefore enable access to the NGA network through an Ethernet-supported virtual connection, identically to an advanced bitstream offer. With respect to PIA, it will enable alternative operators to deploy optical fibre on the access network using the ducts, masts and physical spaces of BT.

It is also noted that the Austrian NRA (RTR) has recently advanced (June 2010) with a proposal to apply a measure similar to VULA on the Member State's historic operator, with prices geared to long-term incremental costs. This proposal received support from the EC.[92]

3.5.2.2 Access to the sub-loop (optical)

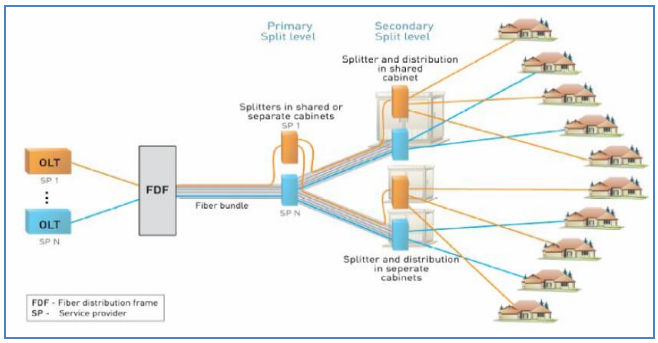
In point-multipoint architecture, the fibre in the access network could be part of a wholesale dark fibre offer[93] (also including the corresponding space in the ODF) provided by the NGA network operator (See Figure 26), if considered necessary, and following a market analysis.

Such a measure would encourage, in particular, a faster deployment of NGA networks and with lower levels of risk and investment by other operators, insofar as almost all the fibre would already be installed. The additional investment on the part of the alternative operators, will thereby be related to fibre link between their network equipment and the optical distribution point (located next to the potential customers).

[92] http://circa.europa.eu/Public/irc/infso/ecctf/library?l=/commissionsdecisions&vm=compact&sb=Title.

[93] That is, unlit optical fibre, not connected to any active equipment.

Figure 26 Access to optical fibre

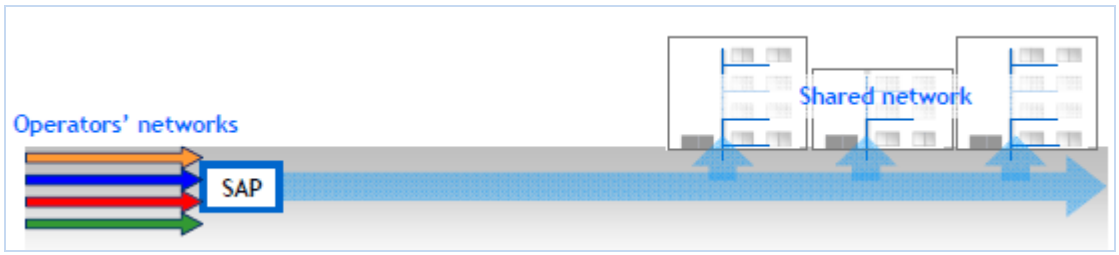


ECI (2009)

This access to the optical sub-loop fulfils the solution proposed and presented by ARCEP, in the public consultation[94] of June 2010 on proposals to regulate access to FTTH networks in areas of low population density, which corresponds to 80% of the French population.

ARCEP considers that the increased sharing of infrastructure will help reduce the costs of deploying FTTH networks, maintaining competition and maintaining the capacity of consumers to freely choose their service provider. To enable various operators to connect to these shared access points (SAP - shared access points) (See Figure 27) in a non-discriminatory manner and with reasonable costs and periods of time, ARCEP considers that access points should be located in the "feeder" segment of the FTTH network of France Telecom (FT). This will ensure that the ducts which enable this connection to these access points have sufficient capacity to accommodate multiple networks in parallel.

Figure 27: Access to optical fibre networks (FTTH) in areas that are not densely populated



Source: ARCEP

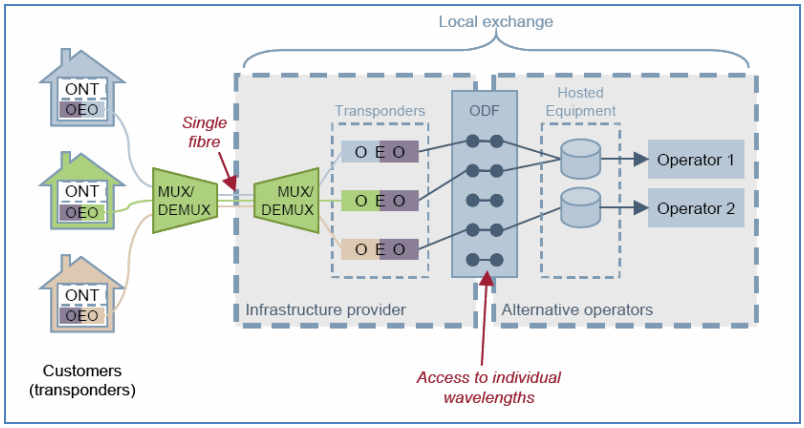
3.5.2.3 WDM-PON Access

On a WDM-PON network, individual wavelengths could be assigned per operator, allowing the sharing of various elements of the physical network while maintaining a dedicated bandwidth for each one, meaning that fibre unbundling (dedicated to the customer) may

[94] *Projet de décision précisant les modalités de l'accès aux lignes de communications électroniques à très haut débit en fibre optique en dehors des zones très denses* (http://www.arcep.fr/uploads/tx_gspublication/consult-projdec-ftth-zmd-110610.pdf).

occur in the exchange, implying changes at the level of active equipment (e.g. AWG, OLT) and at the level of terminal equipment. This technology is currently undergoing standardization; as such, it may be complex to promote non-proprietary solutions (see section 3.4.2.2.2 above).

Figure 28 *Unbundling* WDM PON

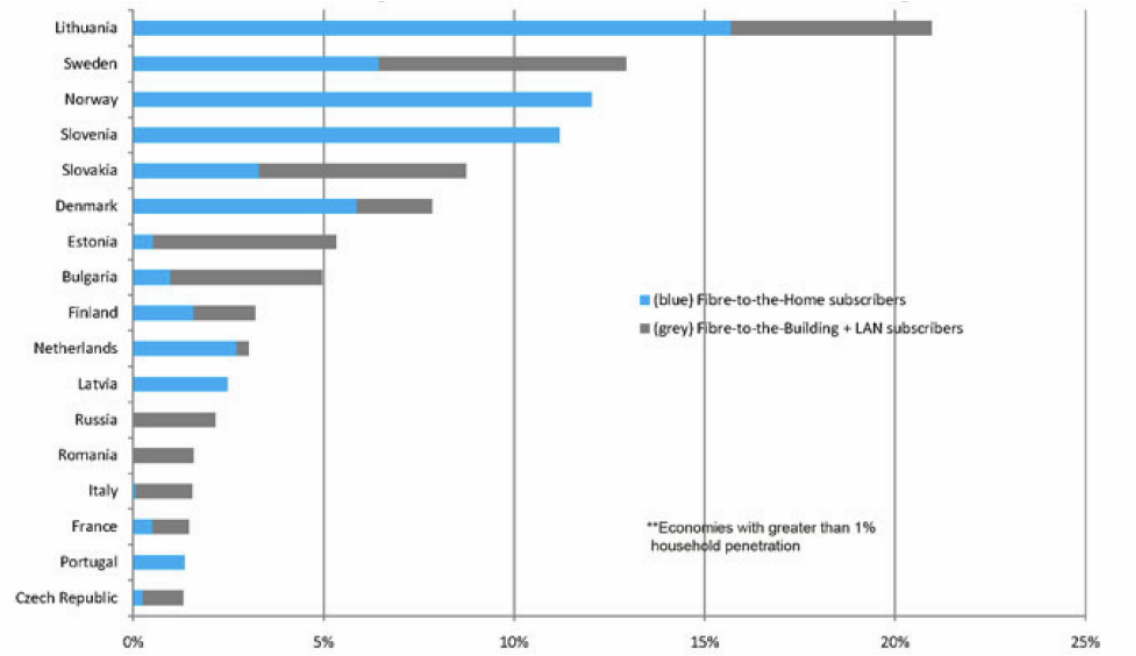


Analysys Mason (2009)

4. International panorama

As at the end of the first half of 2010, Portugal occupied 16th position in the group of European countries with highest FTTH penetration, with a penetration rate reported of around 1.4%, according to the FTTH Council Europe (see **Error! Reference source not found.**). According to the same source, there was a total of 52 500 FTTH customers on the same date.

Figure 29 Rate of household penetration of FTTH/B+LAN[95] in terms of homes connected (first half of 2010)



Source: FTTH Council

Globally, the five economies that were at the top of the rankings in terms of the penetration rate of homes connected with FTTH/B were, at the end of the first half of 2010 and according to the FTTH Council, South Korea, Japan, Hong Kong, Taiwan and Lithuania.

Data from the FTTH Council and IDATE, released in 2010 and referring to June 2009, show that, with regard to FTTX, FTTH and FTTB topologies remained the most widely used worldwide, with more than 62% of connected subscribers, followed by FTTX/LAN topologies (with 31% of subscribers) and VDSL (with 6% of subscribers). It is noted, however, that in Europe VDSL saw penetration at a rate nearly comparable to FTTH/B.

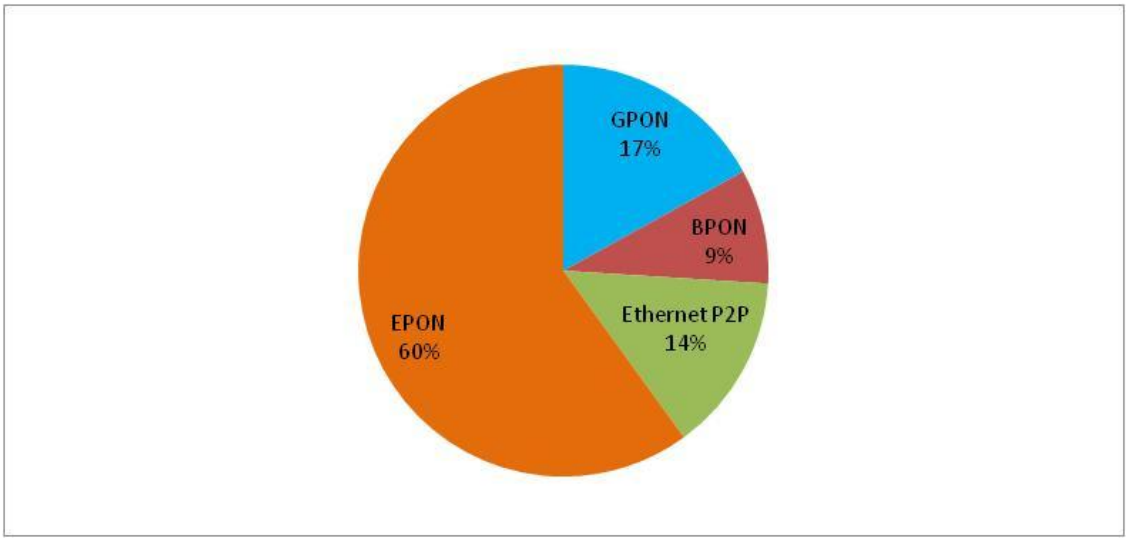
For such, it will be necessary to contend with the fact that these architectures, in particular FTTB, constitute the easiest solution for operators to increase their offer of bandwidth in

[95] *Local Area Network.*

different countries with densely populated areas, especially in Asia and increasingly in emerging countries, in addition to it being considered, compared to VDSL, more "future proof".

The technologies used in FTTX access are shown in Figure 30. EPON is the most widely used FTTX technology. It is noted that Asia, a pioneer in the roll-out of FTTX, uses this technology almost exclusively, with the main operators in Japan and South Korea its main promoters.

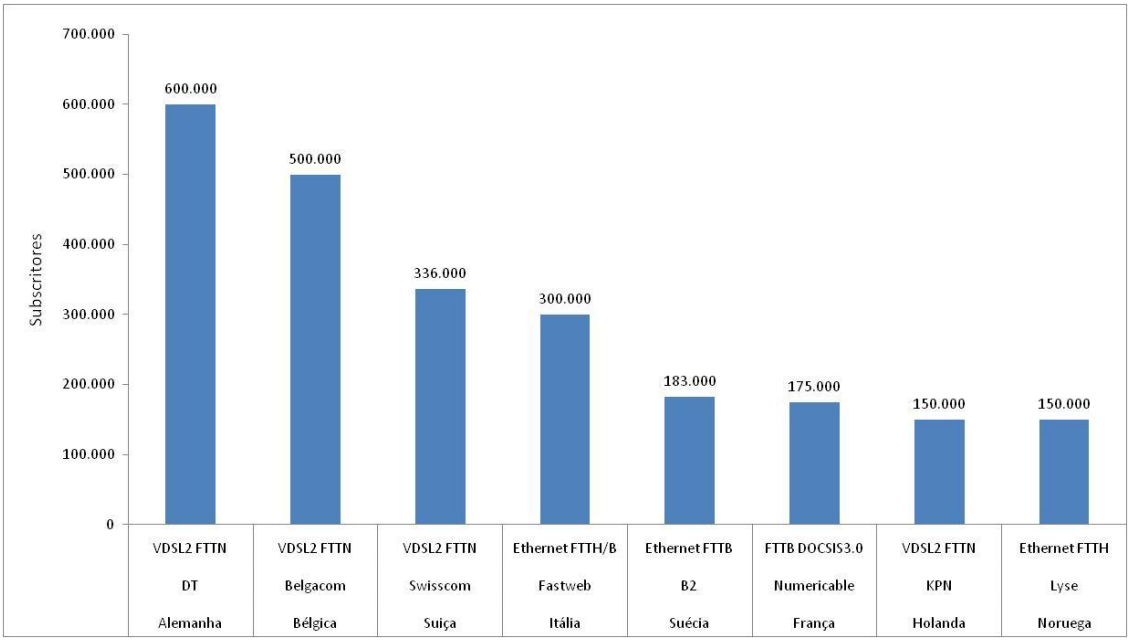
Figure 30 Technologies used in FTTX access (2008)



Source: ICP-ANACOM with data from STAI and FTTH Council (2010)

Note is made of the diversity of architectures used by different operators (see Figure 31).

Figure 31 Leading operators in Western Europe, in terms of FTTX and VDSL subscribers (June 2009)



Source: ICP-ANACOM with IDATE data (2010)

The dynamism of the alternative operators, which, according to IDATE data, represented 74% of the total FTTH/B subscriber base, is clear, as is the role of "utilities" and municipalities (together accounting for 9.6% of FTTH/B subscribers).

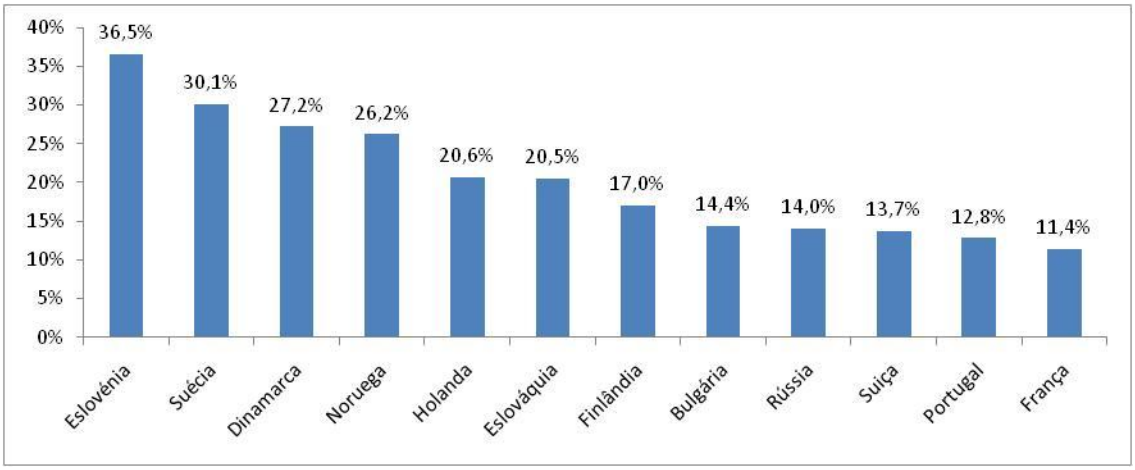
The historic operators, however, becoming more involved, representing 15% of FTTH/B passed homes in Europe in December 2009, including Russia (compared with 10% in June 2009). Alternative operators accounted for 74% of homes passed with FTTH/B in Europe and 24% of all subscribers.

Apparently, this trend seems to suggest an interdependent relationship between investment in NGA and the development of competition, with mutual reinforcement.

On the demand side, one of the most important aspects affecting the user take-up of FTTX is the price borne by the user when signing up to these new services. On the supply side, in many cases, operators want their customers to migrate from ADSL to FTTH/B so that they can begin to monetize their investments.

According to forecasts from *Heavy Reading*, in December 2014, the penetration rate in terms of FTTH homes in Europe, will be as shown in Figure 32. With regard to Portugal, these forecasts may be an underestimate, given the latest data on trends in the number of cabled and connected homes.

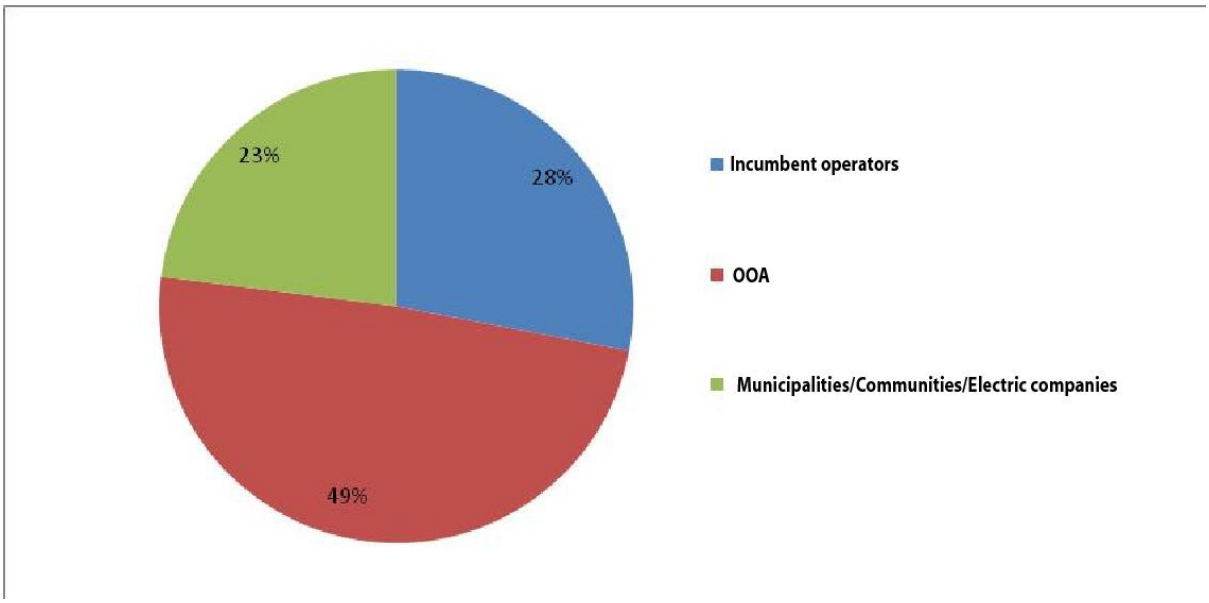
Figure 32 Forecast of penetration rate in terms of FTTH homes in December 2014



Source: ICP-ANACOM with data from Heavy Reading

The same forecasts suggest that connection to FTTH networks will be made by market agents distributed as shown in Figure 33.

Figure 33 Link to FTTH networks by type of economic agent in 2014



Source: ICP-ANACOM with data from Heavy Reading

According to IDATE data from 2009, regarding five operators from other countries (including Spain, France, Holland, Japan and Portugal), which offer both packages of 100 Mbps with ADSL2 and FTTH/B, it is clear that prices of package using fibre were higher, except in the case of France.

An examination of prices charged for broadband offers in different geographical areas showed clear differences between Europe, USA and Asia.

Prices in the United States were generally higher than those charged in Europe. For example, in April 2010, Verizon charged about 108 euros[96] per month just for access with a downstream speed of up 50 Mbps. Interestingly, for a "triple play" bundle with downstream speed of up to 35 Mbps, telephone and television (including 385 digital channels and 90 HD channels), the operator, also requiring a loyalty period of two years, charges about 90 euros[97] per month.

This compared, for example, to 54.90 euros a month charged by one of the service providers in activity in Portugal in the first year of subscription (59.90 euros per month subsequently) for a *"triple play"* package including Internet access with downstream capacity of up to 50 Mbps, 116 TV channels and unlimited telephone calls to other national fixed networks and twenty international destinations (in this case from 9 pm). For 99.90 euros in the first twelve months (104.90 euros after twelve months), the same service offered a *"triple play" package* with downstream capacity of up to 200 Mbps, with the remaining services identical to those mentioned in the previous package.

The highest broadband speeds are available in Asia, where several operators, including HKBN in Hong Kong and KDDI in Japan, have announced offers with up to 1 Gbps. Simultaneously, Asia also seems to be the continent with the lowest prices for FTTH/B offers. For example, Taiwan's Chunghwa Telecom offers 100 Mbps access for a monthly fee of 25 euros and SK Broadband in South Korea, for the same access speed with television included, charges 24 euros per month.

The comparison of prices of packages offered by different providers, encompassing services supported by FTTH/B is complex, since there is considerable diversity among the services offered. Notwithstanding the differences between the specific characteristics of the services considered, a comparison between prices charged by service providers active in Europe and Asia with respect to *"triple play"* packages (including telephone services, television and Internet with downstream speeds of 100 Mbps), could suggest that prices in Portugal are likely to trend towards closer alignment with those charged in other countries.

Below, an outline is made of the current situation in Germany, Australia, South Korea, USA, Finland, France, Greece, Holland, Italy, Japan, New Zealand, United Kingdom, Sweden and Singapore.

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[96] 144.99 U.S. dollars (exchange rate on 06.04.2010).

[97] 119.99 U.S. dollars (exchange rate on 06.04.2010).

4.1 Germany

In November 2005, DT (Germany's historic operator) announced its new strategy for broadband and fixed services based on innovation, investment and growth; focus on the customer and quality and efficiency of services; increase in market share supported by bundles of services; improved organization and sales processes; and development of multimedia services.

This strategy included, *id temporis,* proposed high-speed broadband of up to 50 Mbps for "premium" customers (For most households an offer of 20 Mbps was envisaged) based on FTTC with VDSL, as support for "triple play" offers to a base of 32 million customers, IPTV with one hundred channels and convergent fixed-mobile services.

As such, DT planned to transpose the features of the PSTN/ATM network to a predominantly Ethernet/IP network by 2012. The investment in NGN in 2006 and 2007, gradually superseding the existing network, reached close to 3 billion euros (not including an investment of an additional 3 billion euros applied to the development of VDSL in street cabinets and on 18,000 km of fibre).

Initially, as planned, fifty cities were covered. Over the medium term it is expected that about 25% of German households will be covered in the short term and 50% in the long-term. According to estimates by Cullen International, of December 2010, the percentage of homes connected using FTTC+VDSL2 would be even less than 3%.

In March 2010, DT initiated a new strategy with the aim of expanding the company along the whole value chain and position the company as a partner to sectors such as energy, software and media. In terms of NGN, DT aims to connect 4 million homes with fibre by 2012 (10% of all homes in Germany) along with the capture, by 2012, of 2.5 million to 3 million entertainment focused customers, reaching 5 million customers in that area by 2015.

At the same time, by 2015, DT hopes to achieve total revenues of around 30 billion euros, focusing investment in five strategic areas:

a) Mobile Internet: DT expects to increase its revenues in terms of data traffic, from about 4 billion euros in 2009 to about 6 billion euros in 2012 and about 10 billion euros in 2015;
b) Internet based Products: especially "*Scout24 family, Musicload*, *Videoload*, *Software* and *Gamesload*" - Increasing revenues from 0.8 billion euros to values between 2 billion and 3 billion euros in 2015;

c) Link to home: subscribers will be able to enjoy secure access to universal services through different technology platforms. Revenues in these areas - including access to broadband - is expected to increase from 5 billion euros to around 7 billion euros in 2015;
d) T-Systems[98]: it plans to increase external revenue from 2 billion euros to around 8 billion euros though dynamic services and cloud computing;
e) Long term revenue opportunities in intelligent network services for industries such as energy, health, media and automobile.

These services include applications developed by a third party that will be facilitated by DT. These services include health care using smart phones or telemetry in vehicles. Other planned applications include smart electricity meters *("smart grid")*, which allow consumption to be tracked in real time, enabling consumers to better manage their energy consumption. Forecasts indicate that ICT solutions will enable a reduction in emissions of CO_2. DT aims to generate total revenues of around one billion euros in this area by 2015.

The activities of DTs main competitors with regard to NGN supported services are geographically circumscribed. These include, for example, Netcologne[99] in Cologne [approximately 13 thousand homes connected, with plans to cover 55 thousand (about 90% of residential housing in Cologne) by 2011, with an estimated 120 million euro investment for the period 2006-2011], M-Net in Bavaria, Kabel Baden-Wurttemburg in the State of Baden-Wurttemburg (which recently began deployment of an HFC network, aiming to cover 3.5 million homes, representing about 70% of homes in State and 9% of households in Germany) and certain "utilities". In general, the majority of DT's competitors offers mostly FTTB and FTTH accesses, alongside HFC accesses with DOCSIS 3.0.

DT's retail offers include, in certain cases, speeds of 100 Mbps and other lower speeds (around 50 Mbps) when supported on VDSL, as is the case of HanseNet or Vodafone Germany; these operators support their offers over DT's VDSL network, which interconnects, at hundreds of meters from the MFUs (*multifunction units*) of these operators. It is further noted that on 10.02.2009 nine of the regional operators[100] founded an association of operators (BUGLAS) with fibre or HFC networks.

[98] DT Division dedicated to systems integration, computing and network services and "e-business".

[99] In 2010, this cable network operator, owned by the city of Cologne, announced Internet service offers at speeds of 1 Gbps (see http://www.fiberevolution.com/2009/12/netcologne-announces-1gbs-service-for-2010.html). Its offers are supported using DOCSIS 3.0 or FTTB, with 39,800 homes connected in February 2010.

[100] Some members are already operating HFC networks and have implemented DOCSIS 3.0.

On 04.11.2009, the regulator published a framework for the use of an atlas of broadband infrastructure in the country[101] (included in the broadband development strategy), including the conditions for data entry into the atlas and setting out who is authorized to access it.

As a result of uncertainty about a "regulatory holiday" (that is, the NRA would be "barred" for a period from regulating NGN infrastructure and services) granted by the German government, which was questioned by BNetzA and the EC, and which sparked an infringement procedure against Germany that took the country to the European Court of Justice, there has been some uncertainty about the pace of VDSL deployment by DT.

The decision of the European Court of Justice, taken in December 2009, ruling that section 9a of Germany's Telecommunications Law, by establishing this so-called "regulatory holiday" for investment in new markets was illegal, put an end to this uncertainty.

As such, on 07.12.2009, BNetzA specified the obligation of DT to provide alternative operators with access to its copper network including access to its street cabinets and ducts. The aim is also to also enable these operators to offer speeds similar to those of DT (VDSL2). If the historic operator has no space available in street cabinets for an alternative provider that requests it, it will be required to provide access to its fibre network. Later, in March 2010, the fees for access to street cabinets and to ducts were specified.

In January 2010, the German Supreme Administrative Court[102], ruled to cancel the obligation of DT to provide access to its VDSL dark fibre infrastructure. According to DT, this deregulation will promote investment by the company over the long term, since in some cities DT changed its initial plan of investment in VDSL, using cheaper technology options, including ADSL2+.

In February 2010, DT asked BNetzA, to include the cable network in the regulatory oversight, whereby provision should be made for obligations of access to third-party operators.

In May 2010, the first formal meeting of the NGA Forum, a body chaired and moderated by BNetzA, was held in order to discuss specific matters with relevance to NGA deployment. The main topics discussed were related to open access, interoperability, infrastructure sharing and co-investment. This NGA Forum sees participation by high-level representatives of operators, associations, the horizontal competition regulator and the ministry responsible for the sector. It also involves invited experts with considerable experience in the sector. It is

[101] http://www.bundesnetzagentur.de/media/archive/17626.pdf.

[102] The *"Bundesverwaltungsgericht"*.

expected that the results of the discussions will, when possible, be published on BNetzA's website.

It is noted that back in February 2009, the Federal Government established a target that, in 2010, 100% of family households would be served by broadband at 1Mbps and that 3/4 of these properties would be served by downstream speeds of at least 50Mbps in 2014.

Total public investment, including co-investment by the European Agricultural Fund for Rural Development (EAFRD), will amount to around 600 million euros, with EC giving confirmation in July 2010 that this project is compliant with community rules on state aid.

The new Broadband Atlas[103] released by the Federal Ministry of Economics and Technology (BMWi), suggests that so far coverage has reached 98.5% of households with downstream speeds of at least 1 Mbps. The German government expects the target established for 2010 will be achieved in the first half of 2011, as mobile operators begin to deploy LTE.

According to Cullen International, the 2014 target is attainable, given that cable operators, which have coverage of 60% of households, intend to upgrade the network to 100 (or 128) Mbps by around 2012. Moreover, DT plans to have coverage in 2012 of 30% of households with FTTC+VDSL2 and 10% with FTTB/H. Furthermore, many local and regional operators have begun to deploy networks beyond areas of NGA deployment by DT and by cable network operators.

From 12.04.2010 to 20.05.2010, an auction of spectrum was held for the allocation of 360 MHz on the following frequencies: 800 MHz (this band is commonly referred to as the "digital dividend" and has added value due to its propagation characteristics), 1.8 GHz, 2.0 GHz and 2.6 GHz. With the aim of reducing info-exclusion, obligations have been imposed in the licenses to provide minimum coverage of 90% of the population by January 2016 in areas currently without broadband (rural areas). The auction earned 4.4 billion euros, of which 3.5 billion were derived from the frequencies of the "digital dividend". DT, winner of one of the auctions, intends to use the digital dividend spectrum to expand the LTE network into rural areas and the spectrum of higher frequencies to expand the 3G and LTE coverage in cities.

As in Portugal, the importance of Germany's historic operator in the deployment of NGN is very significant, both in allowing alternative operators access to its infrastructure, and through its own investments.

[103] Not to be confused with the atlas launched by the German regulator which is a database of passive infrastructure (see http://www.zukunft-breitband.de/BBA/Navigation/Breitbandatlas/breitbandsuche.html).

Both in Portugal and in Germany, the dynamism of the providers of services supported by cable networks is clear, encouraging investment by other service providers. The predictability and stability of the regulatory framework, enabling NGN investment to develop on a continuous and rapid basis, also appears evident in both cases.

Meanwhile, the network architecture predominantly adopted by DT (VDSL2) differs from that adopted by the Portuguese historic operator, given the different characteristics of existing networks and expected cost benefits.

4.2 Australia

In Australia, the promotion of investment and competition in broadband and in particular in the NGN, has focused on the introduction of a vertical separation solution, in a context in which, prior to discussion of this measure, the historic operator (Telstra) had not announced any plans for investment in NGN. To the contrary, even in 2005, it reported that its copper network was capable of another fifteen to twenty years of operation.

As such, after the Australian government began to consider an operational separation of Telstra, in November 2005 (after testing in the suburbs of Brisbane) this operator announced plans to implement FTTN within five years and with a minimum speed of 12 Mbps in all households of Australia's five major cities, comprising a large section of the country's total population.

However, since the government failed to provide the operator with a "regulatory holiday" (a condition that Telstra considered necessary for the viability of the investment), the investment plan was "frozen" back in December 2005.

This was followed, in August 2006, by a series of negotiations between the historic operator and the government, with a view to studying the feasibility of alternative plans for the widespread deployment of NGN. The result was unsuccessful, which outcome is not unconnected to Telstra unwillingness to be subject to principles of open network and regulated prices.

However, Telstra upgraded its ADSL network, which resulted in increased speeds offered to the end-user up to 8 Mbps (20 Mbps in households located less than 2.5 km from an exchange).

In any case, Telstra's investment in NGN has remained at low levels even after the implementation of the operator's operational separation, which may possibly be explained by the somewhat incipient characteristics of the adopted separation measures taken (only

relatively loose *"Chinese walls"* between the wholesale and retail units, with few incentives for effective transparency).

This explains why, according to latest data from the OECD (June 2010), the percentage of broadband access in fibre in Australia is very limited (only 0.1 subscribers per 100 inhabitants). Also according to the same source, Australia occupied 18th position in the OECD's ranking of broadband penetration (with 24.5 subscribers per 100 inhabitants) in the group of thirty countries for which the OECD compiles data.

In addition to this measure, the structural separation of Telstra (which saw, *ab initio,* opposition from the operator's shareholders) was approved by the Australian Senate in late November 2010, including the division of the company into various wholesale and retail units, giving it, in parallel, more freedom to bid in future spectrum auctions.

This measure stemmed to some extent from the continued disputes arising from non-price discrimination in the wholesale area (traditionally high volume), although its detection is increasingly difficult due to the proliferation of bundled offers.

It is noted that, in addition to the copper network, Telstra has the largest coaxial cable network in Australia, offering speeds of up to 30 Mbps in some major cities areas, and it recently began testing in Melbourne at 100 Mbps with DOCSIS 3.0.

It should also be taken into account that, in June 2007, the Australian government announced its intention to grant a subsidy of about 611 million euros[104] for the construction of a regional network to OPEL; this company would make broadband available using a combination of optical fibre, WiMAX and ADSL2+, with speeds of up to 12 Mbps. This project was eventually cancelled after a change of government on 02.04.2008, with the minister responsible for telecommunications concluding that OPEL would fail to fulfil the contractual conditions.[105]

In April 2008, the Australian government launched the first public consultation ("*C*all For Proposals - RFP) for the implementation of the NBN plan (National Broadband Network) with a view to deploying a national FTTN network.

The coverage objectives of the Australian government with the deployment of the NBN are shown in Figure 34.[106] In 2008, Telstra's ADSL2+ network was available to 48% of the

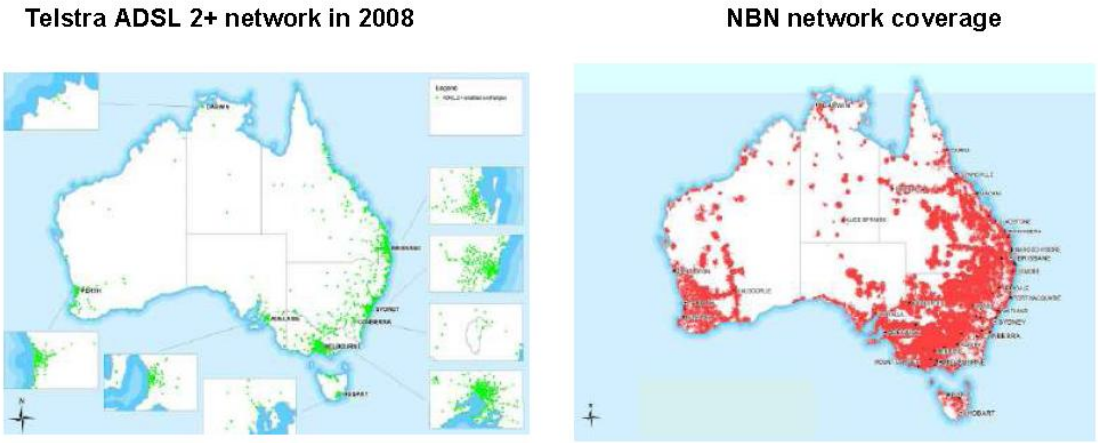
[104] 958 million Australian dollars (exchange rate at the date of 01.01.2010).

[105] http://www.minister.dbcde.gov.au/media/media_releases/2008/019.

[106] According to IDATE (February 2010), Telstra's ADSL2+ network is available to 48% of the population (with a maximum speed of 20 Mbps).

population, with a maximum downstream speed of 20 Mbps. The NBN was intended to cover 98% of the population within five years, with a downstream speed of 12 Mbps. The total development cost of NBN was, at that time, estimated at 9.6 billion euros[107], of which around 3 billion euros would be provided by the government.[108]

Figure 34 Coverage of NGN networks in Australia



Source: Australian Government.

The public consultation closed in November 2008 and five consortia were selected to compete, whereas Telstra saw its proposal rejected. However, a panel of experts, after evaluating the six pre-qualified proposals tender admitted to the tender, found that none of the proposals were of sufficient quality to ensure the money to invest, whereby the tender was made void.

Alternatively, nine of Telstra's competitors joined together to form an operator (FANOC), which set out to make a wholesale offer available for access to a future FTTN network at regulated prices. In December 2007, in a preliminary decision, the Australian Competition & Consumer Commission (ACCC) stated that the FANOC proposal was compatible with the regulatory environment, but noted that key concerns remained with respect to QoS, the formula for setting prices (including return on capital) and in the supervision mechanisms.

Subsequently, on 23.04.2009, the government announced[109] the cancellation of the original NBN plan and its replacement by an even more ambitious plan. As such, the new NBN plan for Australia was announced, which involved the establishment of public-private partnerships

[107] 15 billion Australian dollars (exchange rate on 23.12.2009).
[108] 4.7 billion Australian dollars (exchange rate on 23.12.2009).
[109] http://www.minister.dbcde.gov.au/media/media_releases/2009/022.

(PPP) to invest in NGN. The total cost of this new project amounts to 27.4 billion euros[110], with the State investing 3 billion euros.[111] According to the government, the construction of the NBN network will create 25 thousand jobs per year during each year of construction.

The new NBN plan to be completed by 2018, includes coverage of 93% of the Australian population with FTTH (the remaining 7% will be covered by satellite and wireless technologies), with speeds of up to 100 Mbps (in the case of FTTH) or even up to 12 Mbps (in the case of satellite and wireless technologies). Construction of the network started in Tasmania in 2010.

The National Broadband Network company (NBN Co Limited) was set up on 09.04.2009 with its main activity to construct and operate a nationwide broadband network to provide telephone services and high-speed broadband to homes, schools, and Australian companies; it will invest an amount of up to 26 billion euros[112] over a period of eight years.[113] The government is the principal shareholder[114] (51%), with the remaining 49% open to private operators, not excluding Telstra.

For this investment, the government will make use of the Australian infrastructure fund (Building Australia Fund) and will issue a series of bonds through AIB (Aussie Infrastructure Bonds), which provides a means for families and institutions to invest in the NBN.

Also in the context of the NBN plan, on 16.06.2009, the Australian government announced the creation of a new company, NBN Tasmania Limited[115] with the aim of deploying the national broadband network in Tasmania. This will involve the construction of an FTTP network with speeds of 100 Mbps to about 200 thousand homes and businesses in Tasmania. An investment of 2.7 billion euros is planned.[116]

For its part, in July 2009, Telstra began tests with the manufacturer Nortel to test connections to the order of 40 Gbps to 100 Mbps, between Sydney and Melbourne, which would then facilitate the provision of online video services in these cities.

Back in November 2009, Telstra launched services based on DOCSIS 3.0 on its HFC network in Melbourne (with downstream speeds to the order of 100 Mbps and upstream

[110] 43 billion Australian dollars.

[111] 4.7 billion Australian dollars.

[112] Around 43 billion Australian dollars (exchange rate on 23.12.2009).

[113] http://www.dbcde.gov.au/broadband/national_broadband_network.

[114] The government is planning to sell its stake five years after the network begins operation.

[115] This company formed an operational joint venture with the company Aurora Energy Pty Ltd, owned by the government of Tasmania.

[116] 2.7 billion Australia dollars (IDATE data).

speeds of 2 Mbps), with coverage of one million homes. In response, the competitor Optus announced similar speeds, also supported on an HFC network.

Meanwhile, Telstra has maintained an offer, supported on its mobile network, called "Next G" 850 MHz WCDMA 3 G, with downstream speeds of up to 21 Mbps.

More recently, on 18.12.2009, Telstra and the Australian government agreed on the terms and conditions that would govern the migration of the operator's customers to any future high-speed broadband network.[117]

However, negotiations have taken place with a view to agreeing the terms on which the PPP announced by the government would have access to Telstra's ducts and associated infrastructure.[118]

On 23.12.2009, the government released additional documents related to a public consultation launched in May 2009, moving towards an obligation that, from 2010, all new buildings have to be served by FTTP.[119]

Also at the end of December 2009, Telstra announced the launch of a test FTTP at Pont Cook, Victoria, covering approximately 1,500 residential customers, with the NBN Co invited to participate as an observer (in order, in particular, to assimilate aspects related to customer migration). After concluding the test, Telstra made provisional retail and wholesale offers available with respect to the project.

It is likewise noted that in the State Budget for 2009-2010, a sum of around 3 million euros was allocated[120] to subsidise coordinators of rural broadband networks, which should encourage local governments, communities and businesses to use broadband.[121]

The above measure is part of the *"Regional Backbone Blackspots"* programme (which was allocated funding of 154 million euros)[122] with a view to deploying circuits (with a total length of about 6 thousand km) in areas where there is a lack of transmission infrastructure[123].

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[117] http://www.telecomasia.net/content/telstra-aust-govt-strike-deal-nbn-model.

[118] http://www.telecomasia.net/content/conroys-30b-gaffe-frays-relations-telstra

[119] http://www.minister.dbcde.gov.au/media/media_releases/2009/119.

[120] 5 million Australian dollars (exchange rate of 23.12.2009).

[121] http://www.dbcde.gov.au/funding_and_programs/national_broadband_network/rural_national_broadband_network_coordinators.

[122] 250 million Australian dollars (exchange rate on 23.12.2009).

[123] http://www.dbcde.gov.au/all_funding_programs_and_support/national_broadband_network/national_broadband_network_Regional_Backbone_Blackspots_Program.

Following a tender, execution of the programme was awarded to the company Nextgen Networks.

On 24.02.2010, the Australian government placed two draft laws under public consultation - "National Broadband Network Companies Bill 2010" and "Telecommunications Legislation Amendment (National Broadband Network Measures - Access Arrangements) Bill 2010" - regarding the strategy and business model of NBN Co.[124]

The details of this draft legislation set out the operation of NBN Co as a wholesale supplier offering open and equivalent access to broadband, but which may, under certain circumstances, also engage in retail operations (particularly in the case of public institutions).

In December 2009, NBN Co opened a public consultation **"**NBN Co consultation paper: proposed wholesale fibre bitstream products**"**[125]. The network to be developed will be EPON, with this proposal comprising the conceptual framework in respect of the wholesale offer of bitstream products based on fibre. NBN Co planned, ab initio, to initially offer two bitstream products (layer 2 of the network) of FTTP: The Local Ethernet Bitstream (LEB) and the Aggregated Ethernet Bitstream (AEB).

Meanwhile, the ACCC announced that, taking into account the developments occurring, its review of wholesale access pricing would be suspended until 31.12.2010.

On 02.03.2010, NBN Co[126] announced the first five locations (about 3 thousand buildings per site) where it would launch the experimental FTTP projects.

On 20.06.2010, NBN Co and Telstra agreed (subject to supervening validation by the regulator) to progressively migrate voice and broadband traffic from Telstra's network to the NBN.[127] This deal has an associated estimated value of 8.3 billion euros[128], and it is expected that approximately 18% of this value will be supported by the State. Under this agreement, NBN Co will be able to use the available space in Telstra's exchanges and ducts, in addition to being able to access the dark fibre of the same operator.

[124] These drafts were developed following a process of public consultation conducted in July 2009.

[125] http://www.nbnco.com.au/content/upload/files/NBN001_concept_paper_final.pdf. page=5.

[126] http://www.nbnco.com.au/firstreleasesites/NBNCoFirstReleaseSitesPressRelease.pdf.

[127] http://www.nbnco.com.au/wps/wcm/connect/main/site-base/main-areas/publications-and-announcements/latest-announcements/nbn-co-and-telstra-reach-heads-of-agreement.

[128] 11 billion Australian dollars (exchange rate on 05.01.2011).

On 02.12.2010, NBN Co released a document outlining the accreditation processes and network testing programmes for the organisations wishing to access the NBN.[129]

On 22.12.2010, NBN Co updated the technical specifications of access to the *bitstream* wholesale service of access to fibre agreed in August of this year[130], alongside the disclosure in 20.12.2010 of a greater level of detail on the characteristics of the network and access prices.[131] The initial level of the wholesale offer included a service with downstream speeds of 12 Mbps and upstream speeds of 1 Mbps, associated with a price of 18 euros per month[132], which according to estimates of NBN Co, should result in a cost per user of approximately 76 euro cents.[133]

On 17.12.2010, guidelines and technical details were published related to the installation of ducts and associated infrastructure in sites built from scratch.[134]

It is noted that these initiatives took place following public consultations launched in late October 2010, related to the operational processes of network access to be established between NBN Co and parties interested in gaining access to the NBN[135] and key aspects of the agreement of wholesale access to the NBN network.[136]

At the end of December 2010, the corporate plan of NBN Co. was released.[137] This plan sets out that the NBN will be built over a period of 9.5 years and that its exploration will generate an annual internal rate of return of around 7%, generating accumulated revenues estimated at 15.8 billion euros[138] by the end of its construction.

In March 2010, the operator *Primus Telecommunications Australia* embarked on a modernization of its DSLAM platforms, so as that it might offer IPTV services in the near

[129] http://www.nbnco.com.au/wps/wcm/connect/main/site-base/main-areas/publications-and-announcements/publications/access+seeker+accreditation.
[130] http://www.nbnco.com.au/wps/wcm/connect/main/site-base/main-areas/publications-and-announcements/publications/nbn-co-product-technical-specification-fibre-access-services.
[131] http://www.nbnco.com.au/wps/wcm/connect/main/site-base/main-areas/publications-and-announcements/publications/product-and-pricing-overview.
[132] 24 Australian dollars (exchange rate on 05.01.2011).
[133] 1 Australian dollar (Exchange rate on 05.01.2011).
[134] http://www.nbnco.com.au/wps/wcm/connect/main/site-base/main-areas/publications-and-announcements/publications/greenfield-deployment-of-the-nbn-co-conduit-and-pit-network.
[135] http://www.nbnco.com.au/wps/wcm/connect/main/site-base/main-areas/publications-and-announcements/publications/connecting-to-the-national-broadband-network.
[136] http://www.nbnco.com.au/wps/wcm/connect/main/site-base/main-areas/publications-and-announcements/publications/nbn-co-wholesale-broadband-agreement-public-consultation-opens.
[137] http://www.nbnco.com.au/wps/wcm/connect/main/site-base/main-areas/publications-and-announcements/latest-announcements/nbn-co-corporate-plan-released.
[138] 20.8 billion Australian dollars (exchange rate on 05.01.2011).

future, although it is uncertain whether it will able to attract enough users to already begin selling this service.

The Australian case suggests that relatively "*light*" formulas of vertical separation cannot contain within themselves the necessary incentives for the rapid deployment of NGN. Secondly, it also shows that an approach that precludes the historic operator from an integrated development strategy, is unlikely to have practical results.

4.3 South Korea

In South Korea, 84.2% of the population (48.5 million people) live in urban areas, which tends to facilitate the deployment of electronic communications networks.

According to the FTTH Council, this country has the highest household fibre penetration rate, with an FTTx residential penetration rate of about 52%, with FTTH penetration reaching about 16%.

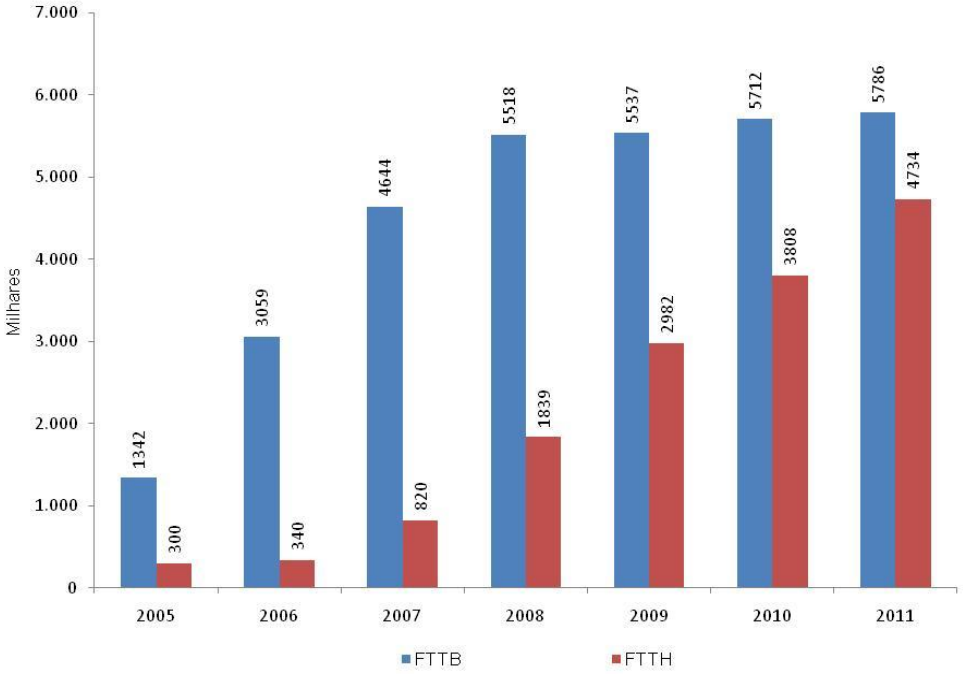
Data from the OECD, referring to June 2010 shows that South Korea has approximately 16.8 million fixed broadband subscribers and 46.3 million mobile broadband subscribers[139], contributing to a joint penetration of 34.4 subscribers per 100 inhabitants.

Fibre, which is growing, represents about 52% of all fixed broadband subscriptions, while XDSL is in relative decline.

According to forecasts stated by Ovum Consulting, the number of FTTX subscribers in South Korea will reach about 10.5 million in 2011, as shown in Figure 35.

[139] The operator SK Telecom, one of the first advocates of WiMAX technology, announced that it would use Long-Term Evolution (LTE) to launch 4G services in Seoul during 2011. While the operator has not affirmed it abandonment of WiMAX, the company's new strategy makes no mention of this technology.

Figure 35 Expected trend in the number of subscribers to FTTH/FTTB in South Korea



Source: ICP-ANACOM, based on Hutcheson (2009)

The three largest operators, KT[140] (*Korea Telecom*), *SK Broadband*[141] and *LG Powercom*[142], dominate the broadband market with a very significant combined share.

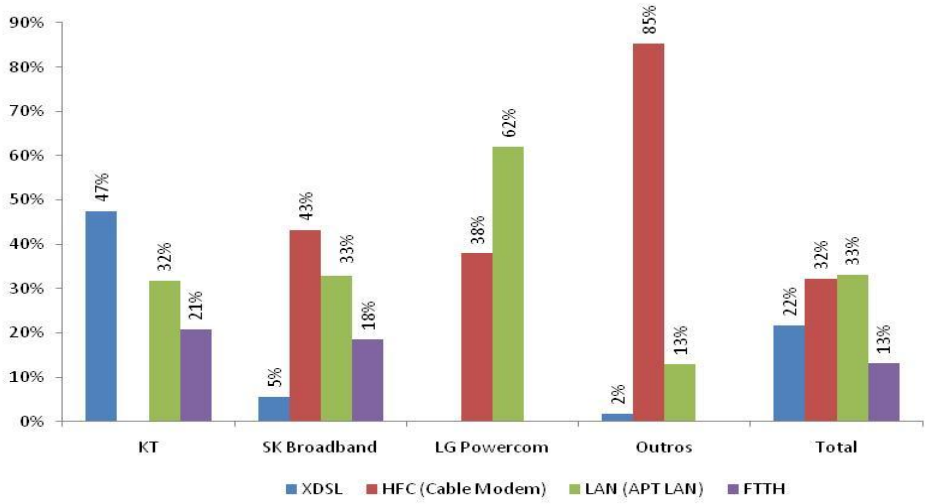
The relative weight of access technologies in the broadband market in July 2009 is shown in Figure 36. The access market is dominated by LAN (5.3 million subscribers) and HFC (5.2 million subscribers) whereas XDSL (3.5 million subscribers in total) is mainly used by KT. FTTH covered 2.1 million subscribers.

[140] South Korea's historic operator

[141] SK Broadband was previously known as Hanaro Telecom. In February 2008, it was acquired by SK Telecom which is part of the SK Group.

[142] LG Powercom is part of the LG group.

Figure 36 Percentage of subscribers per operator and broadband access technology in South Korea (July 2009)



Source: ICP-ANACOM, based on data from KCC

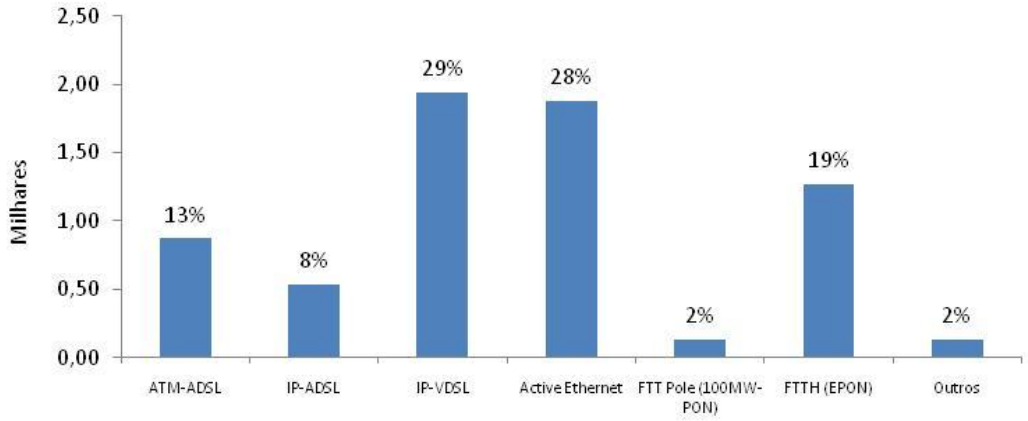
The fibre technology used by KT is almost exclusively EPON (see **Error! Reference source not found.**), whereas the cable operator SK Broadband, which develops HFC and DOCSIS 3.0, opted for GPON.[143] It is noted that KT launched the world's first commercial FTTH offer-based on WDM-PON (Wavelength Division Multiplexing-Passive Optical Networks) in May 2005, using an FTTP service.[144] In 2007, KT announced a partial disinvestment from this technology due to the higher investments. required [145]

[143] Data from Ovum (published on 05.10.2009) - *"The regulatory approach to next-generation access: Asia-Pacific"*.

[144] This commercial offer was preceded by a trial conducted by KT between September and December 2003 with 73 subscribers. This experimental project, led to the establishment of a joint venture in 2005 between two equipment manufacturers, which since 24.07.2009 has offered the market the WDM-PON Ecosystem solution. WDM-PON is not yet standardized, enabling 1Gbps both upstream and downstream.

[145] In May 2009, LG-Nortel and the government agency in South Korea, ETRI "*Electronic Communications Research Institute*" signed a memorandum of understanding in order to promote the standardization of WDM-PON technology.

Figure 37 KT broadband subscribers according to the different technologies



Source: ICP-ANACOM, based on Yoon data (2009)

In terms of FTTH, in November 2009, the total number of subscribers was reported at about 2.4 million, shared by KT (67%) and SK Broadband (33%).

To achieve the reported penetration levels, the approach taken by the government has been key.

In 1987, the South Korean government established a national policy for the development of information technologies in the public and private sectors through a "*Framework Act on Informatization Promotion".*[146] This law established the National Information Society Agency (NIA), with a mission to oversee the construction of high-speed information transmission networks, the use of ICT by government agencies and programmes to promote public access to broadband and literacy digital.

In 1994, the NIA established the *Korean Information Infrastructure initiative (KII)*, with the aim of building a national optical fibre network. This programme would be supplemented with other government programmes[147] to be developed over five years and combining government support with private sector contributions[148] - with the aim of developing an integrated NGN network enabling affordable access *"anytime*" and "a*nywhere*" with the convergence of multimedia services (telecommunications, radio and Internet), allowing provision of residential services using the fixed network at speeds of between 50 Mbps to

[146] http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN025688.pdf.

[147] *Cyber Korea 21* in 1999, *e-Korea Vision 2006* in 2002, *IT Korea Vision 2007* in 2003 and in 2004 the IT 839 programmes (also called *"u-Korea Master Plan"*) *and Broadband Convergence Network* (BCN).

[148] The NCB's period of execution is between 2004 and 2010.

100 Mbps and providing mobile subscribers with speeds in excess of 1 Mbps. Additionally, the government created several agencies to promote access to broadband, in both the public and private sectors.[149]

The KII was key in South Korea's successful evolution to NGA. This strategic programme included direct and indirect support from the government for the development of broadband infrastructure, through loans and other incentives, and covered three sectors; it was conducted in three stages: the KII-G sector (government), KII-P sector (private companies) and KII-T (tests to be conducted by research bodies, *"Korea Advanced Research Network - KOREN"*), as can be seen in Table 4.

[149] The *"South Korean Agency for Digital Opportunity -KADO":* was established to ensure that all citizens had ability to access the Internet, especially citizens with special needs (elderly and disabled) - through specific training programmes; the *"Korea Information Security Agency - KISA"* and the *"Korea internet Safety Commission"* to oversee security on the Internet and consumer protection; and the *"National Internet Development Agency - NIDA"* to promote the Internet society through education and through promotional programmes ("*PC for Everyone"* in 1996, *"Cyber Korea 21"* in 1999 to promote digital literacy and e-commerce.

Table 4 Sectors and phases of the KII programme

	KII-G	KII-P	KII-T
Main participant	Government	Household and business sector	Research centres and universities
Investor	Government	Private	Government and Private
Main objective	*Backbone*	Access	Tests ("*testbed*")
Phase I (1995-1997)	Connect 80 zones	Fibre placement in large buildings	2.5 Gbps between Seoul and Taejon
Phase II (1998-2000)	Connecting 144 areas with ATM services	30% of all family households with ADSL or CATV	GigaPoP[150]
Phase III (2001-2005)	*Upgrade* up to Tera bps	Over 80% of family households with access to 20 Mbps connection	Whole optical network

Source: Lee et al (2001)

The government invested 17 billion euros[151] in the construction of basic infrastructure ("*backbone*") for a nationwide public high-speed Internet network, which operators can use to develop the offer of services to about 30 000 government agencies and research institutes and some 10 thousand schools. The KII-T would enable companies to use laboratory centres for measurement and testing for research and development. Simultaneously, the KII-P sector worked to encourage private funds to build the access network to homes and businesses with the aim of stimulating the development of broadband at the "last mile".

The KII program was supported jointly by government and the private sector, with the government releasing 1.3 billion euros in loans between 2000 and 2005 at reduced costs through the *"Public Fund Program*", while the private sector invested 10.8 billion euros, resulting in a joint public-private investment of about 12.1 billion euros.[152]

Additionally, to stimulate demand for broadband, the government allowed small and medium companies to enjoy a tax exemption rate of 5% of the total that they invest in broadband communications. In addition, some 10 million Koreans were trained in the use of ICT.

[150] Gigapop, abbreviation of *"Gigabit point-of-presence"* (Point of presence of Giga network).

[151] 24 billion U.S. dollars (exchange rate on 04.02.2010).

[152] 16.3 billion U.S. dollars (exchange rate on 12/04/2010).

As such, the government acted as the nation's most active force in the development of the network, both on the supply side and on the demand side.

This pattern, where it is expected that the private sector will drive investment in broadband infrastructure, with the State providing support through subsidies and loans, continued to be followed in the programs which followed KII. In the IT839 and BCN programmes, the government provided more than 52.2 billion euros[153] in low cost loans, while the operators were asked to make an equivalent investment of their own.

Another aspect that has greatly contributed to the development of broadband in South Korea was the government's introduction in May 1999 of a programme of certification of buildings in terms of broadband Internet connection "*The Korean Cyber Building Certificate System"* to accelerate the expansion of broadband Internet services.[154]

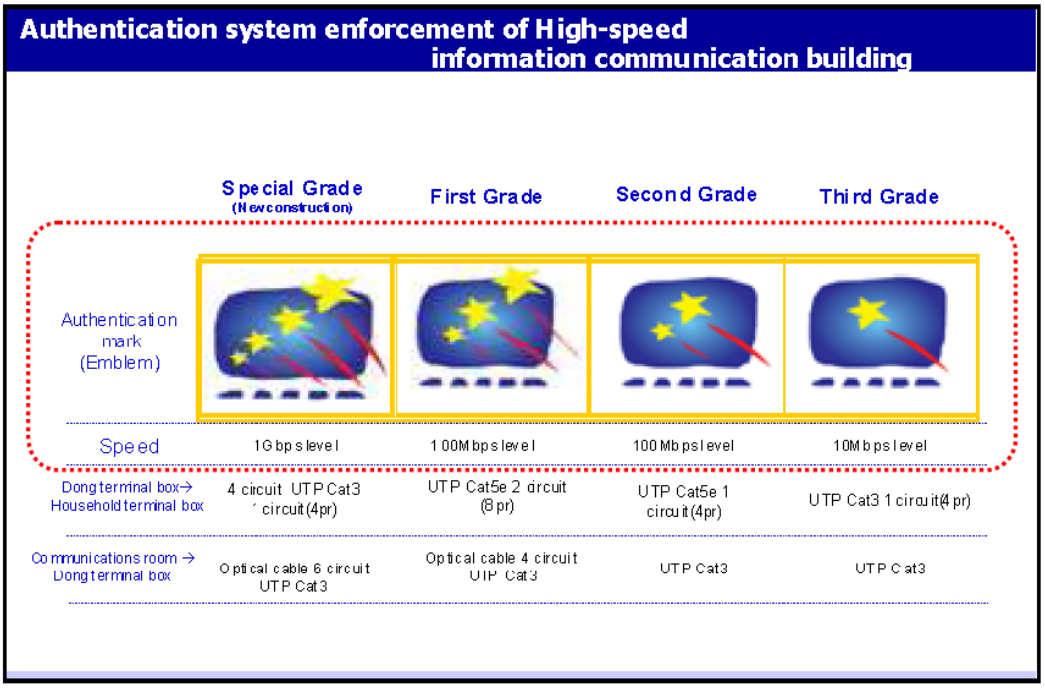
The programme applies to residential buildings with more than 50 residential units and commercial buildings with areas exceeding 3300m^2, and there are currently four classes of certification (1st, 2nd, 3rd and "*premium*") to identify buildings equipped with 100 Mbps, 10-100 Mbps, 10 Mbps and 1 Gbps, respectively (see Figure 38).

In regulatory terms, one of the most important steps was taken in 2003. The MIC (Ministry of Information and Communications) made an amendment to the directive governing the sharing of facilities and equipment to include fibre as one of the wholesale products. The directive set out rules to be applied to the SMP operator (KT) in order to allow access to fibre, leased lines, ducts and masts.

[153] 70 billion U.S. dollars (exchange rate on 04.12.2010).

[154] http://www.ofta.gov.hk/en/ad-comm/raac/paper/raac04_2009.pdf.

Figure 38 Certification system for buildings in South Korea



Source: ONA (2009)

During this process of reviewing the regulatory aspects related to optical fibre, KT argued that allowing fibre access to alternative operators was inconsistent with fair competition policies, since fibre technology is an innovation and depends on the investments of the operators. Therefore, if some regulation of fibre was imposed on KT, the operator would allegedly have no incentive to develop fibre voluntarily and this may impede the desired migration to fibre in South Korea

MIC accepted KT's arguments, opting for a hybrid regime of fibre regulation. Therefore, the obligations of KT with respect to optical fibre were as follows:

a) Until 2004, KT had to allow fibre access to alternative operators, with wholesale prices regulated by the MIC;
b) After 2004, the MIC did not impose any kind of regulation on KT in terms of tariffs.

Following the NCB programme, in January 2009, the government launched a new programme[155] for a very high speed convergence network "*Ultrabroadband convergence network - UBCN*", to be carried out between 2009 and 2013, for the development of fixed broadband - with speeds at home of 1 Gbps[156] and mobile broadband - 10 Mbps. This project established the state of art at a global level. In 2013, it is expected that fixed or mobile Internet speeds will be ten times the current speed and ultra-definition television "*Ultra Definition TV - UDTV*", will be four to sixteen times sharper than current high-definition television "*High Definition TV - HDTV*".

The objectives of this programme, in terms of developing the fixed Internet network, are shown in Table 5. The total cost of the project is estimated at about 21.3 billion euros[157], with central government financing about 4% of that value. It is expected that this project will create 120 thousand jobs.[158]

Table 5 Goals of the UBCN Programme for fixed broadband access

Network	2009-2010	2011-2013
Broadband (50-100 Mbps)	12 million subscribers	14.5 million subscribers
Ultra Broadband (max. 1Gbps)	N.A.	Commercial services launched in 2012 and 200,000 subscribers in 2013

Source: KCC

KT plans to invest about 312 million euros[159] between 2008 and 2015 in order to achieve national FTTH coverage of 100% by 2015 - with an interim target of 92% by 2010.

KT's FTTH investment plan for the next years outlined in Table 6.

[155] Since 1987, South Korea has launched a series of programmes to develop the communications sector, with several taking place simultaneously and contributing to the successful growth of broadband. 1987 saw the launch of *the "Measures to nurture IT Industry (1987-1995)"* programme, targeting industry and the *"National Basic Information System (1987-1996)"* programme focused on the administration, defence, public safety, finance and education. In 1995, the "*Korea Information Infrastructure Initiative* (1995-2005)" programme was launched, focusing on the development of a very high-speed national information network. In 1996, the country launched the "*National Framework Plan for Information Promotion (1996-2000)"* programme was begun, focusing on ten priority areas, with an annual action plan. In 1999, the *"Cyber Korea 21 (1999-2002)"* programme was launched, focused on developing a vision for the knowledge society and in 2002 the "E-Korea Vision 2006 (2002-2006)" programme was launched aiming to maximize the abilities of all citizens in the use of ICT. See http://www.itu.int/osg/spu/ni/promotebroadband/presentations/03-kelly.pdf.

[156] This value is of downstream speed and of upstream speed, corresponding to a speed which is ten times faster than the current one.

[157] 24.6 billion U.S. dollars (exchange rate on 09.02.2010).

[158] http://joongangdaily.joins.com/article/view.asp?aid=2900490.

[159] 500 billion South Korean Won (exchange rate on 09.02.2010).

Table 6 KT'S estimated investment in FTTH[160]

	2009	2010	2011	2012
Investment in € million	37	44	40	39

Source: Hutcheson (2009)

In late 2009, KT was made subject to the obligation to grant access to exterior ducts, as well as those installed inside buildings. KT is expected to increase sharing of their ducts from 5% in 2010 to 23% in 2014.

South Korea has made the deployment of broadband a national issue, with the government emerging as the agent with the most capacity to foster deployment of NGN networks, acting both on the supply side and on the demand side, involving the whole of society through transverse programmes and using the historic operator as a favoured instrument for deploying NGN.

The situation in South Korea is very different from the one in Portugal, although to some degree, some points of coincidence with the national reality can be found. In fact, in Portugal, programmes such as the "e.initiativas" programmes or tax benefits associated with the purchase of computers have been perceived as stimulants to demand. Meanwhile, in addition to the response of operators to growing demand, there was also been an effort in Portugal to create incentives to supply, such as NGN tenders in rural areas and the protocol made between the State and the operators.

4.4 U.S.A.

In late March 2010, there were about 18.2 million passed homes in North America[161] and 5.8 million homes connected to FTTH (**Error! Reference source not found.**), with 98% of this activity being developed in the USA.[162] FTTH has reached almost 16% penetration of households in the USA in terms of passed homes and 5% in terms of connected households.

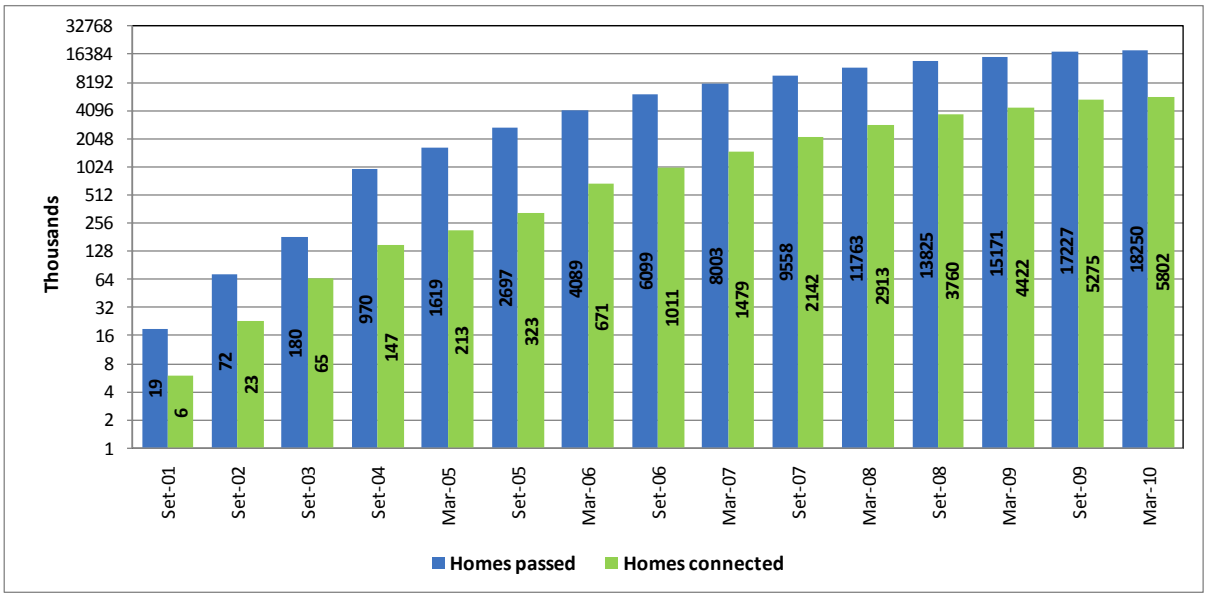
[160] Investment in billions of South Korean Won: 2009-60, 2010-70, 2011-65 and 2012-62 (exchange rate of 09.02.2010).

[161] A home was considered passed where a connection to fibre is available, i.e. a house that already has a connection, or which could request a connection and receive the service within a short period of time.

[162] FTTH COUNCIL, "Fibre-To-The-Home: North American Market Update", April 2010.

As can be seen in **Error! Reference source not found.** (Note the logarithmic scale), the recent trend in volume users of FTTH-based services shows very appreciable momentum (taking into account that 99% of homes represented in this figure are located in the USA).

Figure 39: Households and North America connected with FTTH



Source: Fibre-To-The-Home: North American Market Update For the FTTH Council

In the USA, operators that resulted from the merger of RBOC[163] had more than 4.3 million homes connected in March 2010, whereas Verizon was the provider with the largest number of homes connected, with a significant advantage over the others. The consultants, RV, identified 750 other FTTH providers in the USA, representing more than 1.4 million connections.

With regard to the approach taken by the FCC (Genachowski, 2010) and the Federal Government (NTIA, 2008), this has mainly consisted of a policy to incentivise specific investment projects in rural and remote areas, exemption from sales tax on internet access, in tax benefits for investment in research and development in areas related to broadband or accelerated depreciation of investment in infrastructure for tax purposes (e.g. 30% in the first year), the removal or relaxation of regulatory requirements imposed on local access (e.g. LLU) as a means of promoting investment and incentives in the forms of work organization which will result in intensive use of broadband (e.g. teleworking).

[163] The RBOC operators were created by the breakup of AT&T in 1984 as a result of the antitrust action brought by the U.S. Department of Justice against the former American Telephone & Telegraph Company (later AT&T Corp.), which resulted in the company being split into seven independent and regional companies known as *"Baby Bells"*. The number of RBOC decreased through mergers, with four currently remaining: Verizon (formerly Bell Atlantic and Nynex), Qwest (formerly U.S. West), BellSouth and SBC (originally Southwestern Bell and Pacific Telesys).

In December 2009, the United States government announced that it would invest 133.5 million euros[164] in eighteen projects investing in the expansion of broadband, benefiting seventeen federal states. This investment totalled over 33.6 million euros[165] of public and private sector capital. The goal is to not only provide employment opportunities in infrastructure and production, but also to help reduce the digital divide and foster economic development for communities with little or no access to technology.

Of this amount, 88.7 million euros[166] is targeted at improving communities with insufficient broadband connections, 37.5 million[167] to connect end-users, hospitals and schools, 5.3 million euros[168] to expand computing capabilities for use in public libraries and colleges and 5.3 million euros[169] to fund innovative projects that promote broadband demand within population groups where technology has traditionally been underutilized.

These are the first of broadband programme' projects (5.3 billion euros)[170] targeting broadband projects including current technology and NGN, to help unserved communities to bridge distance and technological barriers through the expansion of access in educational institutions, the possibility of remote medical consultations and the creation of new businesses and companies.

Another concern of the FCC has been to prevent monopolies at the level of the private fibre domain, and it has prohibited (with retroactive effect) exclusivity clauses in the provision of video services in contracts between cable operators and owners of housing blocks[171], with about 30% of U.S. citizens residing in such housing. It is noted that the ban is related to exclusive access to buildings, whereas clauses limiting the advertising of other operators in the building or the use of wires belonging to other operators or owners of the building remain legal.

[164] 183 million U.S. dollars (exchange rate on 05.02.2010).

[165] 46 million U.S. dollars (exchange rate on 05.02.2010).

[166] 121.6 million U.S. dollars (exchange rate on 05.02.2010).

[167] 51.4 million U.S. dollars (exchange rate on 05.02.2010).

[168] 7.3 million U.S. dollars (exchange rate on 05.02.2010).

[169] 7.3 million U.S. dollars (exchange rate on 05.02.2010).

[170] 7.2 billion U.S. dollars (exchange rate on 05.02.2010).

[171] *Multiple Dwelling Units* - Includes apartment blocks, condominiums, cooperative housing, caravan parks (excluding military installations, prisons, hospitals, nursing homes and dormitories).

The FCC also wants to realign the universal service in broadband access, taking as examples the cases of Spain and Finland[172] which have used universal service funds to expand broadband to the entire national territory.

In addition, the FCC is investigating how it can free up spectrum to enable wireless broadband services, looking ahead to the release of 500 MHz for broadband services over the coming ten years, along with greater transparency in the allocation of spectrum and increasing the efficiency of the secondary spectrum market.

Previously structured to provide subsidies to the FTS in rural areas of the country and to low-income families, the FCC believes that the national broadband plan is aligned to stimulate the broadband service in rural areas.

The FCC is also focused on the convergence between television and Internet, which can help enable access to the Internet (about 60% of American households have access to broadband Internet) through television by more people given that 76% of households have a computer and 99% have a TV set. However, most set-top-boxes are not Internet capable. To resolve this problem of convergence between TV and Internet, the FCC believes the industry should develop a set-top-box which could provide access to traditional content as well as the Internet.

Accordingly, on 17.03.2010, the FCC delivered a proposal to Congress, whereby all providers of video services which install set-top-boxes in subscriber homes, ensure that they are capable of being used by third party providers. This rule is already in place for cable network operators, and the same is sought in relation to IPTV services.

According to the FCC, the convergence of television and content delivered over IP makes this a crucial time to promote innovation in this type of equipment, which could support the FCC's efforts towards the adoption and use of broadband in the United States.

In February 2010[173], the FCC's Chairman announced the intention that the United States should become the world's largest high-speed broadband market through the "100 *Squared*" initiative, whose aim is to connect 100 million home at 100 Mbps by 2020 and increase the

[172] In Spain, the government wants service providers benefiting from universal service funds to extend broadband services to every house in their service area by January 2011. In Finland, the established date was 1 July 2010. In both countries, all citizens should be entitled to have a 1 Mbps connection (see http://www.fiercebroadbandwireless.com/story/finland-spain-consider-broadband-universal-service-mandates/2009-11-23).

[173] http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296262A1.pdf.

current penetration in terms of households from 65% to 90%. These measures are included in the National Broadband Plan.[174]

Meanwhile, the FCC issued a number of recommendations to all the parties involved in the development of broadband in the United States, including:

a) The improvement of the "E-Rate" programme - a programme dedicated to connect the country's schools and libraries via the Internet;
b) The modernization of the FCC's rural telemedicine programmes - a programme dedicated to connecting clinics;
c) The development of the broadband network;
d) The development of public-private partnerships to improve Internet take-up and to ensure that all children are able to use the Internet productively and safely;
e) The release of spectrum in the coming years;
f) The reduction of development costs for fixed and mobile networks, through the efficient use of public rights of way and use of ducts;
g) The creation of a interoperable public network to replace the current system.

Also in this regard, FCC conducted a nationwide survey ("*National Broadband Plan Consumer Survey*"), whose published results[175] show that cost and low digital literacy are the basic reasons why about one third of the U.S. population is not connected to high-speed Internet services.[176]

In relation to the rural areas of the United States., the National Telecommunications Cooperative Association (NTCA), a non-profit association representing more than 580 cooperatives and small rural enterprises, conducted a survey (NTCA, 2009) which concluded that the greatest obstacles faced by rural operators in introducing fibre in these areas were the costs of deployment, followed by regulatory uncertainty and the length of local loops[177] (see Figure 40).

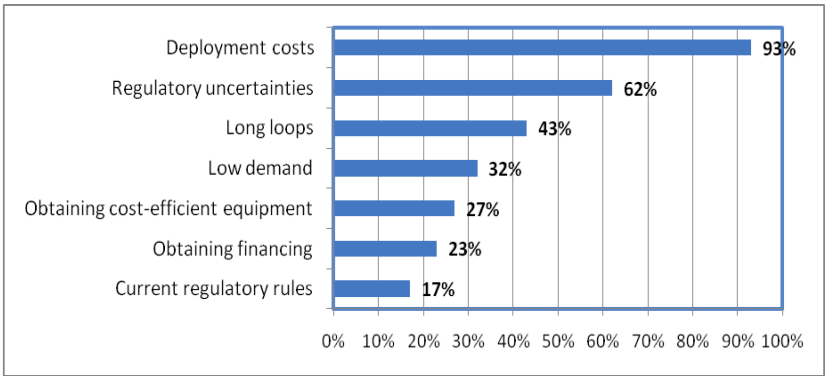
[174] http://www.broadband.gov/national-broadband-plan-progress.html.

[175] http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296442A1.pdf.

[176] Internet broadband or high speed internet, is defined by the FCC as having a minimum speed of 200 kbps in at least one direction.

[177] It is noted that this obstacle would seem particularly relevant for FTTC solutions, and, according to available information, 59% of firms surveyed companies use FTTC or FTTH technologies.

Figure 40: Obstacles to the introduction of fibre in rural areas in the United States



Source: NTCA

Government funds are topped up with the investments made by operators in the development of NGN, highlighting the following:

a) Verizon (FTTP "FiOS", with a coverage target for 2010 of 18-20 million households or 50% of the area where its network is already present);
b) AT&T (FTTN "U-Verse" with a coverage target of 30 million homes in 2011);
c) Comcast (DOCSIS 3.0 cable, with a coverage target of 50 million households or 100% of the existing network in 2010);
d) Qwest (FTTN, with the aim of bringing fibre to a point where it is possible to connect up to three hundred and fifty homes using VDSL2 over copper).

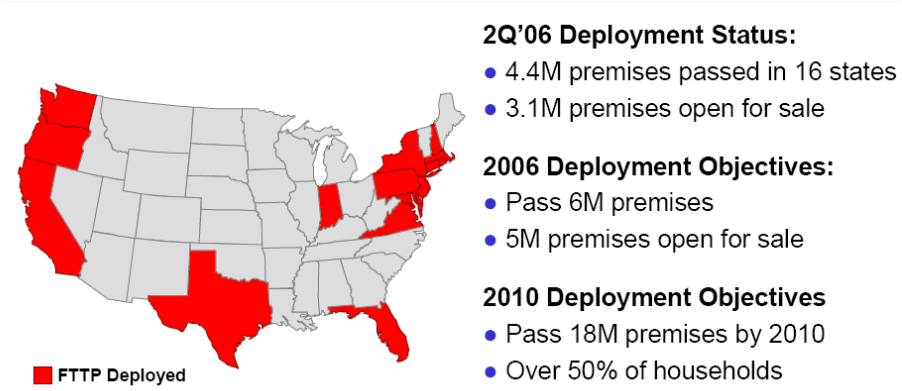
In 2010**, Verizon** planned to invest about 13.1 billion euros[178], covering about eighteen million homes[179] with its FiOS service[180] (based primarily on FTTH, with a small base of FTTB) and expects to have between 6 to 7 million Internet subscribers using this technology this year - See Figure 41. Currently, Verizon's fibre network provides maximum speeds of 50 Mbps downstream and 20 Mbps upstream.

[178] 18 billion U.S. dollars (exchange rate on 05.02.2010).

[179] http://broadbandcensus.com/2009/04/verizon-other-fiber-builders-cautiously-optimistic-about-broadband-recovery/.

[180] See http://www22.verizon.com/content/ConsumerFios.

Figure 41: Deployment of the Verizon Network



Source: Verizon

In early 2008, Verizon announced that the new FiOS connections would be based on GPON topology with *RF Overlay*, in order to provide a reliable video service as quickly as possible. In April 2008, 10% of its six hundred exchanges were ready to support GPON.[181]

Despite this investment in NGN, Verizon has extended its DSL network in 2009 to more than sixteen communities, which corresponded to more than 17 thousand new circuits; this considering that in the short term it is unlikely that all customers will be reached with fibre, whereas their cable competitors continue to increase the capacity of their networks in terms of transmission rates.

At the end of 2010, the FiOS network comprised 15.6 million passed homes. In 2010, Verizon added 197 thousand new FiOS Internet customers, compared to 2009, and 182 thousand television customers, reaching a total of 4.1 million Internet customers and 3.5 million television customers[182].

At the end of 2010, the penetration rate of FIOS was about 32%, (comparing to 28% at the end of 2009). The penetration rate in terms of homes connected to the FIOS television service was 28% at the end of 2010, and was 25% at the end of 2009.

With an average price per bundle of Internet television and voice services exceeding 94.8 euros[183], 20% of homes where FiOS is available are included in the video service and 24% bought the Internet service.

On 20.12.2010, Verizon announced[184] the extension of the offer of the FIOS service to small and medium enterprises in twelve federal states and in the Federal District of Columbia.

[181] See http://www.lightreading.com/document.asp?doc_id=151373.
[182] See http://investor.verizon.com/news/view.aspx?NewsID=1107.
[183] 130 U.S. dollars (exchange rate on 10.02.2010).

Also at the end of 2010, Verizon announced[185] the world's first large-scale deployment of LTE, with services initially offered to corporate clients, with the expectation that coverage in 2014 will coincide with the operator's current 3G network.

Among Verizon's major competitors is the cable operator **Comcast**, whose accumulated revenues in the first three quarters of 2010 totalled 20.5 billion euros (representing an increase of 5.7% over the same period in 2009).[186]

Currently, Comcast provides internet connections of 12 Mbps for 14.6 euros[187] per month in parts of Colorado, having deployed DOCSIS 3.0 in 2009 with speeds of up to 50 Mbps. It is currently performing tests with DOCSIS 3.0 to increase the current speed from 50 Mbps to 100 Mbps. According to data from this operator[188], at the end of the third quarter of 2010, total volume of customers with access to high-speed Internet, voice and television reached 48 million.

Comcast set a goal of making DOCSIS 3.0 available in areas where Verizon has deployed FTTH, intending to modernize its entire network with the standard by 2011.

In areas where DOCSIS 3.0 is available, Comcast offered, in particular, two new levels of service - Extreme 50, with 50 Mbps downstream and 10 Mbps upstream and Ultra 22 with 10 Mbps downstream and 5 Mbps upstream. The penetration rate of the high-speed Internet service, in terms of passed homes, has been growing at a reasonable pace, reaching 29.7% in 2008 (some analysts estimate that the penetration rate will be around 40% in 2011). It is expected that, under ideal conditions, DOCSIS 3.0 will enable the operator to have downstream speeds of 160 Mbps and upstream speeds of 100 Mbps.

There has been a perception that Comcast would not be very interested in state funds for broadband because of what it considers excessive associated regulatory restrictions, particularly with regard to the requirements of net neutrality. Comcast's main concern seems to stem from the fact that net neutrality prevents ISPs from charging content providers for traffic prioritization.

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[184] http://www.fiercetelecom.com/press_releases/verizon-fios-internet-business-now-offers-fastest-mass-market-broadband-ser?utm_medium=nl&utm_source=internal

[185] http://investor.verizon.com/news/view.aspx?NewsID=1096.

[186] 26.6 billion U.S. dollars (exchange rate on 06.01.2011).

[187] 19.99 U.S. dollars (exchange rate on 10.02.2010).

[188] http://www.cmcsk.com/releasedetail.cfm?ReleaseID=523403.

It is noted that besides net neutrality, other regulatory conditions are likely to influence investment in NGA. For example, the National Broadband Plan recommended, inter alia, that the FCC:

a) Revise the regulation of wholesale access, specifically by promoting access to local fibre infrastructure;
b) Ensure fairness and reasonableness of pricing and other conditions governing access to products (such as high-capacity lines) offered by local monopolists to business customers or to alternative operators in order to connect their infrastructure to customer premises;
c) Ensure a balance between the deployment of fibre networks by local monopolies and the disconnection of the traditional copper networks in their possession, insofar as the latter occurrence may impair the ability of alternative operators to provide broadband services through the unbundling of the local loop;
d) Promote roaming in data transmission, so that broadband network operators will be encouraged to build networks with broad and competitive coverage.

In October 2009, the FCC began discussions related to the rules of net neutrality, based on the four freedoms of the internet (*"internet freedoms"*) approved in 2005, plus rules of non-discrimination and transparency. As such the rules regarding *net neutrality* are as follows:

a) Consumers have the right to access lawful Internet content of their choice;
b) Consumers are entitled to use applications and services of their choice, subject to the requirements of the law;
c) Consumers are entitled, pursuant to applicable legislation, to connect devices of their choosing which do not cause harm to the network;
d) Consumers have a right to competition among network providers, application providers, service providers and content providers;
e) A broadband ISP should treat legal content, applications and services in a non-discriminatory manner;
f) A broadband ISP must disclose information relating to network management and other practices that may be reasonably necessary for users and content, applications, and service providers to assess the regulatory safeguards provided.

However, in early April 2010, an appeals court in Washington D.C. ruled[189] that the FCC will have exceeded its powers in ruling on net neutrality in a case involving the operator Comcast. There was, at that time, a perception that this could inhibit more assertive action by the FCC in this area in the future.

The case focused on a 2008 FCC decision which prohibited Comcast from blocking its broadband subscribers from accessing an online file-sharing technology known as ("BitTorrent"), based on the second principle that service providers cannot be *"gate-keepers"*.

In this context, the FCC, which defines high-speed Internet as an information service, announced its intention, on 06.05.2010, to reclassify the Internet as a telecommunications service[190]. This would enable the FCC to regulate prices and access, as if it were any other telecommunications service and would give the FCC control over aspects of broadband Internet network neutrality.

This announcement, known as the "*Third Way Approach To Internet Regulations*" generated a wave of protests, not only among ISP but also in Congress itself - 228 members of Congress from different political backgrounds, have asked the FCC to abandon its plans for the announced reclassification.

Finally, on 21.12.2010, the FCC adopted a decision on *net neutrality,* with three key rules:

a) Transparency - An ISP must publicly disclose accurate information about its network management practices, performance and commercial terms, which is sufficient for consumers to make informed choices as to the use of services and so that providers of services, content, applications and equipment can develop, market and maintain offers on the Internet;
b) No blocking under reasonable network management conditions - A fixed broadband ISP may not block legal content, applications, services and equipment. A mobile broadband ISP may not block consumer access to Internet sites that are legal, nor access to voice telephony or video telephony in competition with its own services;
c) Prohibition of unreasonable discrimination - A fixed broadband ISP may not unreasonably discriminate against the transmission of lawful traffic, whereas reasonable network management practices shall not constitute unreasonable discrimination.

[189] http://pacer.cadc.uscourts.gov/docs/common/opinions/201004/08-1291-1238302.pdf.xml=http://www.cadc.uscourts.gov/isys/Alldbs/isysquery/bffa5b09-ac78-4e36-b204-7b5ada083a64/6/hilite/.

[190] http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-297944A1.pdf.

In January 2011, Verizon challenged this decision in the courts, considering it abusive. In any case, the FCC is maintaining its decision and is preparing a legal defence.

AT&T is building an FTTN network, using VDSL2 to reach their customers. According to estimates by the operator, the cost of this architecture will work out at around 262 euros[191] per customer. **Table 7** shows a comparison of the costs of homes passed and connected between Verizon and AT&T.

Table 7: Cost per home cabled and connected to FTTC and FTTH[192]

	AT&T FTTC	Verizon FTTH			
	2006	August 2006	Objective end of 2006	2008 Stanford Bernstein	2010 Forecast by Verizon
Cost per passed home	300	873	850	817	700
Cost per connected home	550	933	880	718	650

Source: Broadband Stakeholder Group (2008)

In December 2009, AT&T launched the "U-verse High Speed Internet Max Turbo" service, which offers broadband with speeds of 24 Mbps and 3 Mbps downstream and upstream, respectively, with a price of 47.4 euros.[193]

At the end of 2009, AT&T had 17 million passed homes and wants to reach 30 million passed homes in 2011. At the end of 2010, the operator had around three million U-Verse TV customers.

On 05.01.2011, AT&T announced plans to begin offering LTE services in some U.S. cities in the second half of 2011, intending to cover between 70 to 75 million people by the year's end. The deployment of AT&T's LTE network should accelerate in 2012, concluding in 2013.

[191] 360 U.S. dollars (exchange rate on 05.02.2010).

[192] http://www.broadbanduk.org/component/option,com_docman/task,doc_view/gid,1009/Itemid,63/.

[193] 65 U.S. dollars (exchange rate on 10.02.2010).

Unlike Verizon and AT&T, **Qwest** seems to have no interest in being present in the traditional TV business, believing that with FTTN and a capacity of 40 Mbps, it will be able to offer an appealing video experience, including digital television, high-quality video and video on-demand.

Qwest, present in ten federal states of the USA, is taking FTTN to a point where on average it is possible to connect up to three hundred and fifty houses, using VDSL2 over copper.[194] The company is not choosing to take fibre to the end user, since, in 75% of cases, its infrastructure uses ducts (unlike Verizon, which mainly uses aerial infrastructure). As such, if the company chooses to bring fibre to the premises of the end user, this would mean an increase in costs with the large scale deployment of ducts.

Following an approach that its CEO called "*super conservative*", Qwest plans to invest "only" 219 million euros[195] in FTTN solutions in the coming years[196], to increase its market share of residential broadband from 32% to 45%, intending to reach a penetration of 40% in 2010, with a cost that was estimated in 2007 to correspond to 128 euros per passed house. According to data from this operator, Qwest's FTTN network already covered 4.5 million homes as at the end of the third quarter of 2010.

The additions of broadband customers have made a special contribution to Qwest's operating revenues, which reached 2.3 billion euros in the third quarter of 2010[197] (representing growth of 3.9% over the same period of 2009).

It is noted that an important factor in driving NGN in the United States appears to be the fact that the overwhelming majority of consumers are interested in purchasing access to "high-speed/broadband internet" bundled with other services (Competeinc, 2008).

On 10.02.2010, **Google** announced its decision to deploy an experimental FTTH network with fully open access, supporting symmetrical speeds of 1 Gbps (twenty times more than the current offer of FiOS). This network will reach between 50 thousand and 500 thousand homes during its test phase.[198] While announcing its intention to open the network to third parties, it has not announced whether it will provide broadband services in the retail or wholesale segment, but nevertheless issued an extensive invitation, notably to public, municipal and community authorities, setting out a PPP-type financing model.

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[194] http://www.telecomengine.com/article.asp?HH_ID=AR_4490.

[195] 300 million U.S. dollars (exchange rate on 10.02.2010).

[196] http://www.dslreports.com/shownews/More-Qwest-VDSL-Details-90280.

[197] 2.,9 billion U.S. dollars (exchange rate of 06.01.2011).

[198] http://googleblog.blogspot.com/2010/02/think-big-with-gig-our-experimental.html.

On 16.03.2010, the National Plan for Broadband was published: Connecting America - The National Broadband Plan. The Plan's mission "is to create a high-performance America, a more productive, creative, efficient America in which affordable broadband is available everywhere and everyone has the means and skills to use valuable broadband applications". This plan sets out to achieve six goals:

a) At least 100 million U.S. homes should have affordable access to actual download speeds of at least 100 megabits per second and actual upload speeds of at least 50 megabits per second by 2020.
b) The United States should lead the world in mobile innovation, with the fastest and most extensive wireless networks of any nation;
c) Every American should have affordable access to robust broadband service, and the means and skills to subscribe if they so choose;
d) Every American community should have affordable access to at least 1 gigabit per second broadband service to anchor institutions such as schools, hospitals and government buildings;
e) To ensure the safety of the American people, every first responder should have access to a nationwide, wireless, interoperable broadband public safety network;
f) To ensure that America leads in the clean energy economy, every American should be able to use broadband to track and manage their real-time energy consumption.

Given the clear differences between the United States and Portugal, particularly in terms of population, land area, per capita income, technological development and political structure of governance, it is difficult to draw conclusions which are directly applicable to the Portuguese case. However, in both cases, it is evident that there is an imperative need to expand info-inclusion (particularly in rural areas) and that the regulator has a role in removing barriers to investment and stimulating, given the existence of growing competition, the development of NGN.

4.5 Finland

The government of Finland expects that at the end of 2010, every household will have access to the Internet with an average downstream speed of 1 Mbps[199], at a reasonable price for all people. This will access speed will, this year, be defined as universal service, without any public funding, whereas the service provider may decide which technology to use.

[199]According to most recent data, published on 30.06.2010, 30% of broadband accesses had downstream speeds equal to or in excess of 2 Mbps.

In late 2015, the government expects that nearly all the country's permanent residences will be located within a maximum of two kilometres of a cable or optical fibre network allowing network access at speeds of 100 Mbps, according to the following conditions:[200]

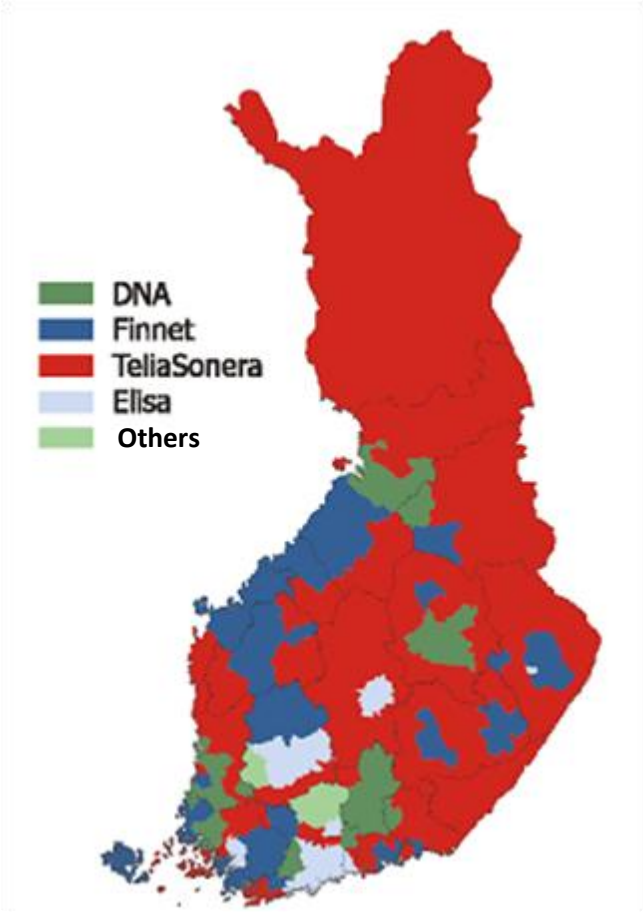
a) Users will pay their connection subscription;
b) In built-up areas[201], the operators will develop NGN networks under market conditions. This will enable coverage of about 95% of the total population;
c) The expansion of coverage to 99% of the population will require subsidies for projects which are not viable in commercial terms, with about 130 thousand homes to be passed under these conditions (mainly in rural or remote areas), corresponding to roughly 5% of the population.
d) The total cost of this project, which the EC confirmed, in May 2010, is compliant with community rules on state aid, will be around 200 million euros, of which 66 million euros will be supported by the State, 41.4 million euros by municipalities, 24.6 million euros by EAFRD and the rest by operators.

It is noted that prior to the launch of this project, ten local NGA pilot projects were begun in 2009, associated with a total investment of 15.6 million euros, 1/3 financed by the government, 1/3 by municipalities and/or by EAFRD and the rest by operators.

There are currently five broadband operators in Finland, as shown in Figure 42, while according to data from FICORA, in June 2008, there were fewer than 10 thousand fibre loops.

[200] http://www.regione.piemonte.it/innovazione/images/stories/innovazione/B3/dwd/parantainen1140.pdf.
[201] The term "*in built-up areas" is not defined*).

Figure 42 Geographic distribution of broadband operators in Finland



Source: Parantainen (2009)

According to latest data from Cullen International, released at the end of 2010, at the end of 2009, the Finnish historic operator (TeliaSonera) achieved coverage, in terms of passed homes, of about 20% of households (the number of households totals about 2.4 million). According to data from the FTTH Council, with reference to the first half of 2010, Finland was in ninth place in the European rankings of FTTH penetration, corresponding to a penetration rate of 3.21%.

FICORA (Finland's NRA) expects that the definition of Market 4[202] encompasses point-to-point optical fibre connections (though with "lighter" obligations than those that have been applied to copper loops) and that the definition of Market 5[203] encompasses all types of optical fibre connections.

[202] Wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location.

[203] Supply of wholesale broadband access

The Finnish regulator is also responsible for managing the payment of state funds, overseeing state aid (presenting an annual report to the ministry) and assessing regional market analyses carried out by provincial government agencies.

It is also noted that a FICORA regulation published in January 2008 requires that the wiring in new buildings comprises cabling which enables broadband access and that apartments are connected to optical fibre networks, wherever available.

The development of NGN in Finland, shows that, in this country, the priority of the state is the achievement of universal broadband, always favouring a network development model, supported by market players. This point is coincident with the public policies pursued in Portugal, although it is more ambitious with regard to the reference speed available in rural areas.

Another important factor comes from Finland being an emblematic country, as a producer of electronic communications equipment, and a cradle of innovative transnational corporations in this field.

4.6 France

In France, the main operators active in the FTTx market are France Telecom (FT), Free, Numericable and SFR, with the major operators bringing the fibre network to the streets of forty cities or urban areas during the past two years.

The "battle of optical fibre" began when, in September 2006, the alternative fixed network operator, Free, launched a "triple play" offer for 30 euros, which included downstream speed of 100 Mbps, free phone calls to forty-two countries and high-definition television. The spread of this offer began in Paris and expanded to other urban areas in particular, Montpellier, Lyon and, more recently, Valenciennes and the outskirts of Paris. This operator envisaged, in 2007, an investment in a point-to-point fibre network of one billion euros over five years, to cover four million subscribers.

It is noted that, in October 2006, Free acquired CitéFiber which in the middle of this year launched a residential optical fibre service in the 15th district of Paris.[204]

As early as 06.12.2009, Free announced its FTTH retail offers in the city centre of Valenciennes in northern France[205] - with downstream speed of 100 Mbps and upstream

[204] The broadband available for each user was 100 Mbits, with 30 Mbits reserved for Internet traffic. The most complete package included digital television and VoIP. The price of the simplest package, that included Internet with unlimited traffic, was 49 euros.

speed of 50 Mbps, and is expected to cover the entire city, about 13 thousand buildings (residences and businesses), in 2010.

SFR set out, in 2007, that it would invest 300 million euros (in 2007 and 2008) in PON architecture networks, in order to achieve a coverage of one million homes. In January 2007, this operator acquired Mediafibre (selling fibre access in the region of Pau), and in April the same year, it also acquired Eren, an operator which had launched an FTTB offer in 2003.

Free, like SFR, is currently focusing the development of its networks basically in areas where there are alternatives to the civil engineering infrastructure of FT, such as the public ducts of Paris.

Also in 2007, another alternative operator, Numericable set out that it would invest 280 million euros in pre-development of FTTH, to cover 1.5 million homes in 2007 and five million in 2008. This operator has started replacing some of its coaxial cable network with optical fibre, in the horizontal part of the network and in about thirty cities or urban areas.

It is noted that in late 2009 Numericable established a partnership with mobile network operator Bouygues Telecom with a view to making a joint investment in optical fibre.

FT's projects to be undertaken from 2007 to 2010 envisage passing one million homes and include a pre-development of FTTH (with PON architecture) estimated at 280 million euros, during 2007 and 2008, and including ten large cities[206] as potentially eligible areas.

On 01.03.2007, FT launched the first commercial FTTH offer in Paris, at 45 euros for an Internet connection of 100 Mbps (flat rate) and a set of services including VoIP and television, with free installation. This offer was preceded by a trial FTTH programme, begun in June 2006 by FT / Orange SA on the outskirts of Paris, which included speeds of 2.5 Gbps downstream and 1.2 Gbps upstream and which had thirty users using a PON network with a price of 70 euros per month.

France has been experiencing high growth in the number of ultrafast broadband subscriptions, with about 100 thousand FTTH/FTTB customers and 320 thousand HFC customers in the third quarter of 2010 (which means growth of 70% and 66%, respectively, compared to the same period of 2009).[207]

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[205] http://www.iliad.fr/presse/2009/CP_041209.pdf.

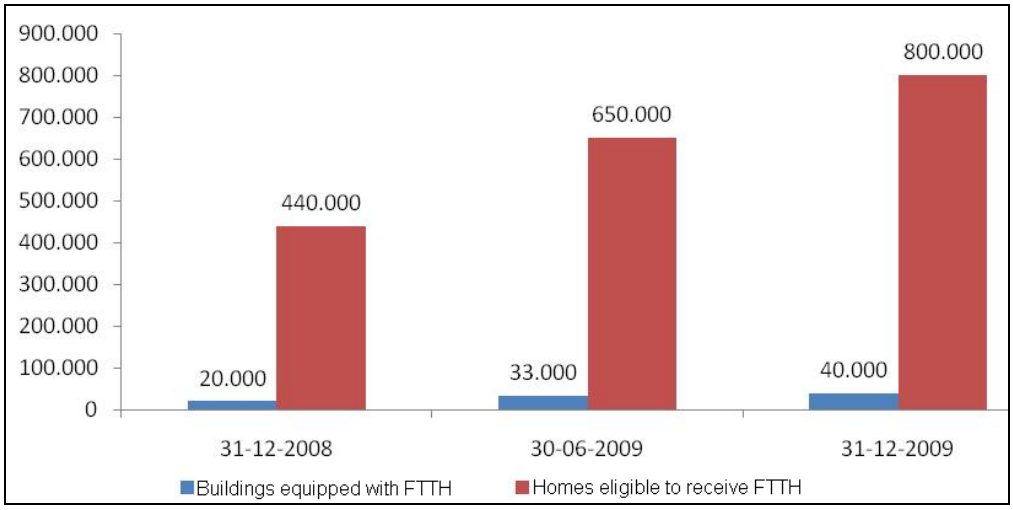
[206] http://www.acist.pt/files/2008-march-PresentationFTTH.pdf.

[207] http://www.arcep.fr/?id=10656&L=1.

A forecast made by ARCEP in 2007, referring to 2013, envisaged 3 million FTTX passed homes in the Paris region, 430 thousand in the region of Marseille, 400 thousand in the region of Lyon, 220 thousand in the region of Lille/Valenciennes, 190 thousand in the region of Bordeaux, 160 thousand in the region of Toulouse, 140 thousand in the Strasbourg region and 90 thousand in the region of Nantes.

Meanwhile, Figure 43 shows the evolution in the total number of buildings equipped with FTTH as well as homes eligible to receive optical fibre.

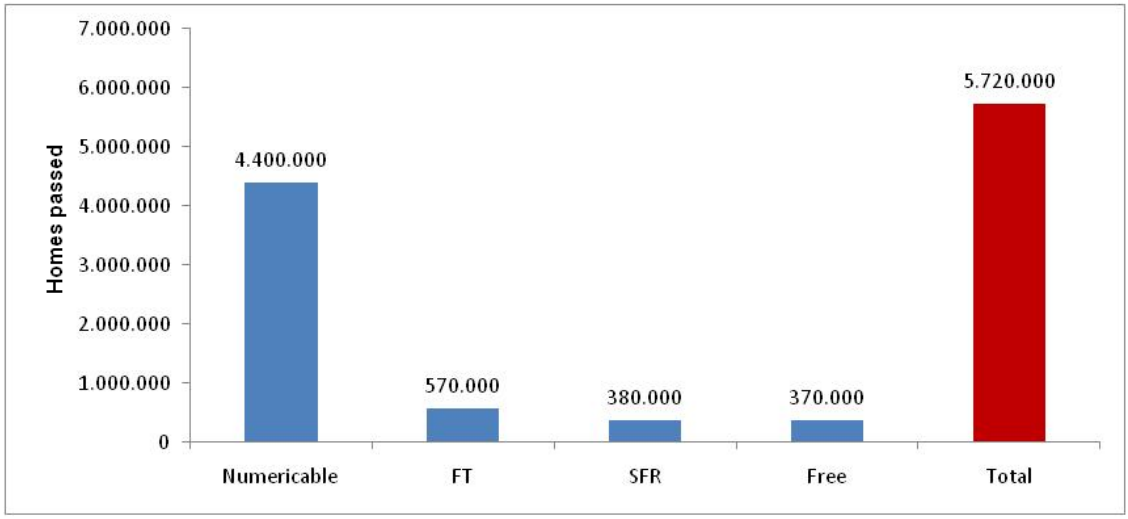
Figure 43 Evolution in the total number of buildings equipped with FTTH and homes eligible to receive FTTH between 31.12.2008 and 31.12.2009



Source: ICP-ANACOM, based on data from ARCEP

According to data from IDATE, in December 2009, France had a total of 570 thousand homes passed with fibre by the historic operator, 5.2 million passed by alternative operators (370 thousand by Free, 380 thousand by SFR and 4.4 million by Numericable).

Figure 44 Number of passed homes in France (December 2009)



Source:ICP-ANACOM with data from IDATE

ARCEP estimates that by the end of June 2009, about 4.5 million homes and businesses were located near an optical fibre network and are eligible to sign up the services thereof, and that a total of 33 thousand buildings were equipped with optical fibre and connected to the network of at least one operator, while there are 650 thousand households located in these buildings which are eligible for FTTH offers[208] (France has a total of 26.28 million primary residences)[209].

On 30.06.2009, again according to ARCEP, there were two hundred cases of "ultrafast" subscriptions to broadband supported by network sharing agreements between service providers. Meanwhile, about 5 thousand households located in one hundred buildings equipped with optical fibre, were connected to the network of at least two operators.

It is noted that ARCEP has been taking steps to examine the conditions of NGN evolution and to take relevant measures to streamline its deployment, namely:[210]

a) Public consultation of 27.07.2007[211], on the shared use of local optical fibre networks, with the objective of ensuring effective sharing of the terminating segment of the fibre network;
b) Public consultation of 27.07.2007[212], on the competitive situation concerning access to electronic communications ducts and the possible regulation of this access, with

[208] http://www.arcep.fr/fileadmin/reprise/observatoire/tres-haut-debit/2009/tab-fibre-thd-070409-eng.pdf.

[209] According to 2006 data from Institut National de la Statistique et des Études Économiques See http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATTEF05235.

[210] http://www.arcep.fr/index.php?id=8650.

[211] http://www.arcep.fr/uploads/tx_gspublication/consult-ftth-mutualisation-immeuble-juillet07.pdf and http://www.arcep.fr/uploads/tx_gspublication/consult-ftth-fourreaux-juillet07.pdf.

the aim of determining the possibility of using existing infrastructure to accommodate cables and thereby considerably reducing operators' costs in the development of a fibre network;

c) Public consultation 22.05.2008[213], on shared use by operators of the terminating segment of optical fibre local loop networks, with the objective of defining the obligations of the "property operator", (the operator responsible for the installation and exploration of the network in the building) with respect to users and other co-operators, as well as their relationship with the property owners or managers;

d) Recommendation of 10.10.2008[214], on shared use by operators of the terminating segment of optical fibre local loop networks; where guidelines are given on aspects of the concluded consultations, especially in the following regard; the role of the "property operator" as the sole interlocutor with users, location of shared access points, forms of sharing the final part of the connection and provision of information to third party operators;

e) Public consultation of 22.06.2009[215], on the draft decision of ARCEP on the modalities of access to very high-speed, optical fibre, electronic communications lines.

In parallel, ARCEP published reports on the development of the NGA, including:

a) Analysis of Relevant Markets[216] (broadband) of April 2008. These basically contain an examination of the changes to the market of wholesale physical infrastructure access (market 4) and wholesale market of enabled offers (market 5) in the public consultations undertaken by ARCEP in December 2007 and February 2008;

b) Summary of the first phase of the evaluation of experimental works regarding "The sharing of optical fibre networks"[217], of April 2009. This report contains an evaluation of an experimental pilot project (started in mid-October 2008), supervised by ARCEP and carried out by operators, in order to assess what the important factors will be in the effective deployment of NGA;

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[212] http://www.arcep.fr/uploads/tx_gspublication/consult-ftth-fourreaux-juillet07.pdf and http://www.arcep.fr/uploads/tx_gspublication/consult-ftth-fourreaux-juillet07.pdf.

[213] http://www.arcep.fr/index.php?id=8455&tx_gspublication_pi1[typo]=8&tx_gspublication_pi1[uidDocument]=607&cHash=e6f0f1eaa2 and http://www.arcep.fr/uploads/tx_gspublication/consult-ftth-mutualisation-mai08.pdf.

[214] http://www.arcep.fr/uploads/tx_gspublication/recomd-mutual-ftth-1008-eng.pdf.

[215] http://www.arcep.fr/uploads/tx_gspublication/projdec-modal-acces-fibre-220609.pdf.

[216] http://www.arcep.fr/uploads/tx_gspublication/adm-htdebit-conseil-concurrence-avril08.pdf.

[217] http://www.arcep.fr/uploads/tx_gspublication/synt-fibre-thd-150409.pdf.

c) Optical Fibre[218] ("Rapport relatif au déploiement des réseaux en fibre optique suite à la première phase de travaux d'expérimentation et d'évaluation menés sous l'égide de l'ARCEP"), of April 2009. Analyzes the state of evolution of the experimental project mentioned above and debates the current state of optical fibre in France, including the state of development of optical fibre networks in "high density areas";

d) Very High Speed Reference Framework of 31.12.2008, April 2009[219], containing a compilation of data concerning the situation of very high-speed Internet in France.

In June 2009, two conventions were also published to define and formalize the development of optical fibre networks:

a) *"Modèle de convention pour l'utilisation des installations de génie civil pour les réseaux de communications électroniques"*[220], with the objective of defining the general, technical and financial conditions by which communities (groups of citizens or entities) agree the right of the operator to use the premises of the community in order that it is possible for operators to develop FTTX;
b) *"Convention type d'installation, gestion, entretien et remplacement de lignes de communications electroniques a três haut debite en fibre optique"*[221,] aimed at formalizing access to buildings and dwellings for the installation of fibre, preserving the rights of owners and the exercise of competition, pursuant to decree-law no. 2009-54 of 20.09[222] regarding the installation, management, maintenance and renovation of very high-speed, optical fibre, electronic communications lines in a building.

The way in which the French regulator has developed a national strategy for NGN also included the launch and supervision of a pilot project, begun in mid-October 2008, which will result in the following reading of the FTTH market:

a) The operators involved in the development of optical fibre were in clearly different positions, especially on the one hand the historic operator who used its ducts (inherited from the time of monopoly) and on the other Numericable that has been gradually replacing its coaxial network with fibre;

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[218] http://www.arcep.fr/uploads/tx_gspublication/rapport-fibre-thd-070409.pdf.

[219] http://www.arcep.fr/fileadmin/reprise/observatoire/tres-haut-debit/2009/tab-fibre-thd-070409.pdf.

[220] http://www.arcep.fr/uploads/tx_gspublication/convention-type-_fourreaux-avril2009.pdf.

[221] http://www.arcep.fr/fileadmin/reprise/dossiers/fibre/conf-220609/convention-type-thd-220609.pdf.

[222] http://www.legifrance.gouv.fr/affichTexte.do;jsessionid=4FFB0C120CB223B93E99BB97E99D6B3E.tpdjo10v_2?cidTexte=JORFTEXT000020099745&categorieLien=id.

b) The OAO's FTTx coverage was dependent on access to existing ducts, considered essential infrastructure, and therefore requiring regulation so that these operators are able to invest, minimizing regulation of higher levels of the network and limiting the duplication of civil construction works by local authorities;
c) Access to buildings was a major problem for all operators, while it was clear that users do not want to be limited in their choice to the operator which is first to install its network on the property);
d) The sharing of infrastructure between operators is essential to avoid duplication of fibre networks.

In this pilot project, 2 thousand homes were selected, spread out over twenty locations in Paris (where several operators have already developed horizontal networks, mono-fibre or multi-fibre) and a detailed study was conducted of the interaction between the various actors present. Five operators participated in this project (FT, SFR, Free, Numericable and Covage).[223]

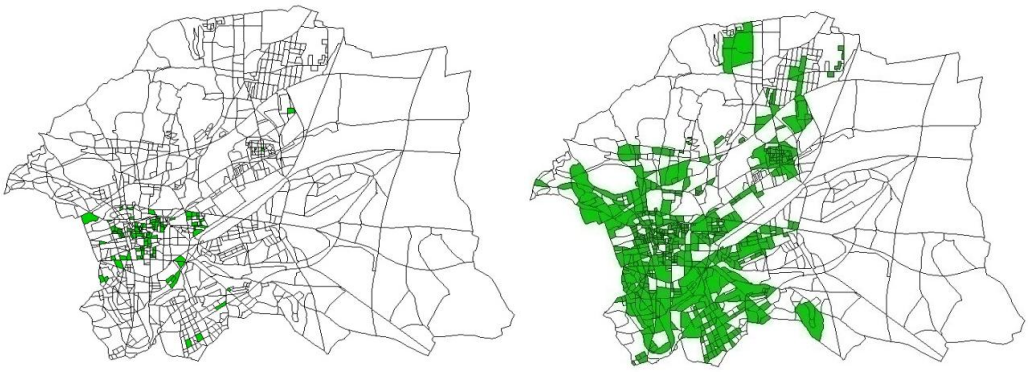
Additionally, important measures were taken on access to ducts. In 2007, ARCEP audited the ducts of FT in ten cities and a sample of a thousand distribution cabinets to evaluate the availability of space. This measure was based on the fact that access to existing ducts could reduce the cost of civil construction works incurred by the alternative operator by five to ten times, which costs represent 50% to 80% of the development costs of a new optical fibre loop.

In 2010, ARCEP launched a public consultation, running until November, on the pricing methodology with respect to access to ducts. The NRA deemed that duct access fees should be based on volume, i.e., based on the calculation per metre (length) and per square centimetre of the FT duct used. According to ARCEP, this is the best approach to support the efficient use of ducts by operators deploying competing networks. The rates are differentiated between the ducts of the termination segment of the access network and the feeder segment (area between the OLT and the distribution point), since demand will vary according to the technological options of operators (e.g. between point-to-point and point-multipoint FTTH).

As seen in Figure 45, if the OAO had no access to the historic operator's duct network, only 13% of homes would be connected by the OAO with FTTH, compared to 79% in cases where they can access existing ducts.

[223] http://www.eett.gr/conference2008/pdf/Curien.pdf.

Figure 45 Homes connected by alternative operators with FTTH where they have access vs. no access to the duct network of FT



Source: Vandeputte (2007)

In this context, on 15.09.2008, FT announced its reference duct access offer, replacing its previous offer from late 2007, thereby fulfilling the obligations contained in the decision adopted by ARCEP's market analysis on 24.07.2008, requiring FT to allow access to its duct infrastructure, under transparent and non-discriminatory conditions and with cost-oriented prices.

This set of regulatory developments culminated in July 2009 with a draft decision of ARCEP on *"Très haute débit"*[224]*,* through disclosing the development strategy of NGN in France. This draft received the favourable opinion of the French Competition Authority on 22.09.2009.[225] Subsequently notification was made to the EC, which on 05.11.2009 issued its favourable opinion recommending that in addition to the measures proposed by ARCEP, consideration be given to the unbundling of access to the fibre loop.[226]

On 22.12.2009, ARCEP (Decision No. 2009-1106)[227] submitted a final document on the development of "ultra-fast" broadband. Essentially it coincides with the content of the draft decision of July 2009, whereas the following points should be noted:

a) The definition of high density areas[228] where more than one network, of PON or point-to-point architecture, can be developed (about 5.5 thousand households, where

[224] http://www.arcep.fr/uploads/tx_gspublication/projdec-mutual-fibre-280709.pdf.

[225] http://www.autoritedelaconcurrence.fr/user/standard.php?id_rub=316&id_article=1248.

[226]http://ec.europa.eu/information_society/policy/ecomm/doc/implementation_enforcement/article_7/summary_decisions/fr_2009_0993.pdf and http://circa.europa.eu/Public/irc/infso/ecctf/library?l=/commissionsdecisions/fr-2009-0993_enpdf/_EN_1.0_&a=d.

[227] http://www.arcep.fr/uploads/tx_gsavis/09-1106.pdf and http://www.arcep.fr/uploads/tx_gspublication/RecoARCEP_mutualisation_fibre_01.pdf.

[228] In general terms the definition of high-density areas follows the following selection methods: a) urban units in Metropolitan France with a population of more than 250,000 inhabitants, b) those urban units from a) in which at least 20% of the housing units are located in large blocks of flats with more than 12 units, c) urban areas were selected where at least 50% of the housing units fulfil the requisites of b) or others where plans to perform optical fibre rollout have been announced.

deployment costs are the lowest), whereby alternative operators are completely independent of the historic operator. In these areas, the owner or manager of the property is responsible for choosing the provider which officially, by signing a contract, will be responsible for installing and maintaining the vertical fibre network in the building. This "operator of the building" has the obligation to inform its competitors, so that they have the opportunity to share the development costs of this network from the start, putting in their own networks. The shared access point is placed outside the building - thereby preventing the creation of local monopolies;[229]

b) Prior consultation – It is recommended that a prior consultation is implemented at municipal level, to identify any operators interested in co-financing the deployment of optical fibre in buildings, in order to define, ab initio, the method of installing the lines and the model of each operator's access to the building's fibre (shared or dedicated fibre line);[230]

c) Building cabling – Regarding the installation of fibre inside buildings in high density areas, “the operator of the building", in the month after it is named as such, has an obligation to inform other operators about its intention to install cabling in the building with optical fibre lines, whereas the form in which this information is provided is regulated [231] so that the remaining operators may properly scale their network taking these elements into account and, if they see fit, install a dedicated fibre line inside the building;

d) ARCEP recommended that this process of disclosure and compilation of expressions of interest from other interested operators should last not more than three months. If no operator manifests an intention to install a dedicated line, "the operator of the building" may install a single line per property, and must provide interested operators with access to this line at the pooling point;[232]

e) It was, however, recommended that to ensure a satisfactory after-sales service, "the operator of the building" should install at least two lines, one for any third-party operators. If there are manifestations of interest by n operators, it will be obliged to

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[229] The exception to this rule includes all buildings connected to accessible ducts (as in Paris) and all the buildings with twelve or more flats, in which cases the shared access point may be found inside the building.

[230] In the first phase of this consultation the parties would manifest their interest in pre-financing the installation of fibre as well as the technical configurations desired (shared or dedicated fibre line, intention to install interconnection equipment, etc.). In the second phase the "operator of the building" will be able to enter further and more detailed discussions with the operators manifesting interest subsequent to the first phase. This second phase may lead to an agreement with the interested third party operators, which may be formalized through a signed convention with the "operator of the building".

[231] Comprising, among others, the following elements - address of pooling point and addresses of the buildings which it serves, means of access, technical characteristics of the equipment to be installed

[232] Pooling point or point of flexibility is where the connection is made between the optical fibre cables of different flats and different service providers.

place n lines per interested operator. However, for operational reasons, the installation of more than four optical fibre lines per household was not recommended, nor was the sharing of the same line by more than four operators;

f) Access to building fibre lines by third party operators which did not manifest interest from the beginning – In this case, the "operator of the building" has the obligation to provide access to these operators through the pooling point, using shared fibre or a dedicated line.

Therefore, by establishing the definition of density areas, ARCEP created geographically differentiated regulation. At the same time, it clarified important aspects regarding the role of operators in properties, the publication of reference access offers and exchange of information between operators and the principles governing access prices (initial investment and/or risk premium for future access).

ARCEP considers that the incremental costs, due to the development of multi-fibre networks in dense areas, will be about 5%[233] (between 3 to 4 million euros).

ARCEP's vision, regarding the coordination of operators in order to avoid duplication of fibre network infrastructure within buildings (being economically unreasonable), is in line with the view of the French legislature.

In fact, the Law of the Modernization of the Economy (Law no. 2008-776 of 4.08.2008)[234], sets out that new buildings should be equipped with fibre and that the first operator to install fibre within a building is bound to provide non-discriminatory access to other operators.

In this context, and as a consequence of the cited determination of ARCEP of December 2009, in the first quarter of 2010, FT, SFR, Numericable and Covage published their reference offers for the construction and pooling of vertical cabling in properties.[235]

Regarding areas that are not considered as being of very high density, in June 2010, the French regulator launched a public consultation, whose key elements included upholding sharing between the operators of the FTTH access network, connection to access points according to reasonable costs and timeframes and non-discriminatory conditions, location of access points in FT's *"feeder" network* (promoting the installation of cables of various

[233] FT, for its part, considers that the additional cost would amount to about 40%.

[234] http://www.telecom.gouv.fr/archives-actualites/2008/aout/5-aout-2008-publication-loi-modernisation-economie-1818.html and http://www.legifrance.gouv.fr/affichTexte.do;jsessionid=?cidTexte=JORFTEXT000019283050.

[235] http://www.arcep.fr/index.php?id=8571&L=1&tx_gsactualite_pi1%5Buid%5D=1251&tx_gsactualite_pi1%5Bannee%5D=0&tx_gsactualite_pi1%5Btheme%5D=0&tx_gsactualite_pi1%5Bmotscle%5D=&tx_gsactualite_pi1%5BbackID%5D=2122&cHash=608731c4c7

operators in ducts) and scaling the capacity of access points between 300 and one thousand lines.

At the same time, ARCEP is performing oversight of three working groups (which include participation by operators and in some cases, local and regional authorities) on the deployment of fibre, related to operational aspects, with issues concerning the sharing of infrastructure in less densely populated areas and with matters related to specifications and with the efficiency of the equipment at shared access points.

One feature of NGN development in France, was the intervention of local authorities in the development of fibre networks, undertaken pursuant to article L 1425-1 of the General Law over Regional Administrative Structures (*Code Général des Collectivités Territoriales - CGCT*), which establishes the conditions for action by local authorities in the electronic communications sector. These may provide infrastructure and networks and operate them based on the principles of equality and free competition, but cannot intervene in respect of end-users, except in cases where there is no serious interest from private operators.[236]

The intervention of local authorities forms part of the national strategy for the development of Internet broadband networks in France, especially in rural areas, executed through the public service outsourcing mechanisms [237], PPP and SEM[238] (see Figure 46).

The DSP and PPP have contracts of 15 to 20 years, and represent a concession to sell wholesale services and/or fibre to local, regional, national and international operators. Specific agreements may also permit the construction or sale of dark fibre. There are about 100 municipalities and about 30,000 communities in France linked to these projects.

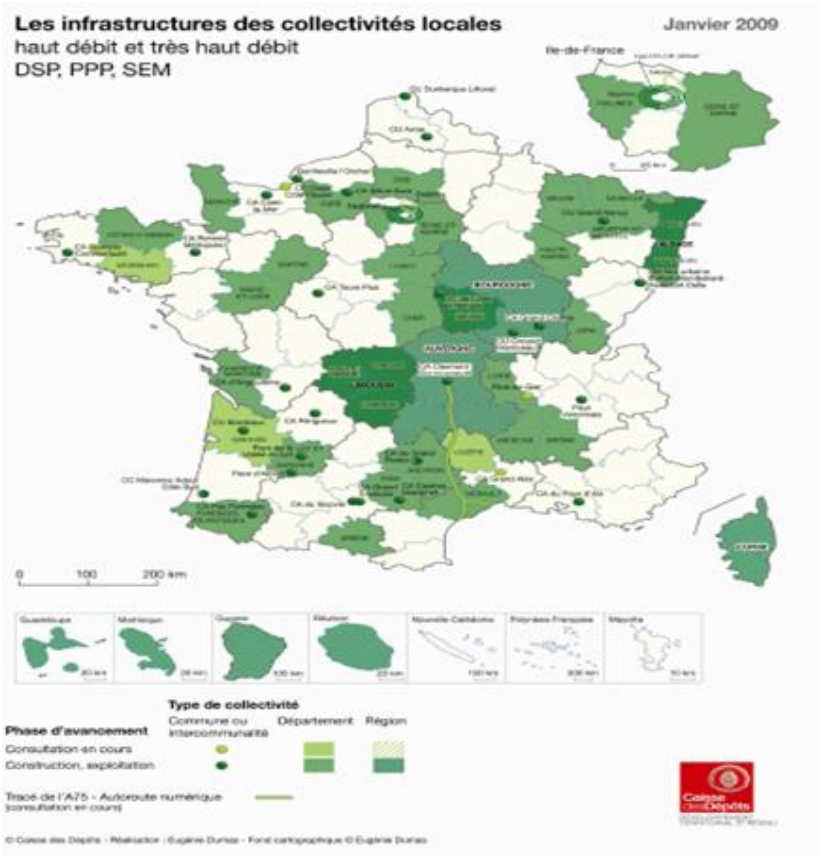
ARCEP recognized the value of the role performed by local authorities in the development of NGA in France, and in 2004 created the Committee of Public Initiative Networks (*Comité des Réseaux d'Initiative Publique - CRIP*) to drive dialogue and information exchange between local authorities, operators, and public agencies interested in electronic communications.

[236] http://www.arcep.fr/uploads/tx_gspublication/rapport-bilan-rip-221208.pdf.

[237] DSP (*Délégation de Service Public*). A contract whereby a moral person of public law entrusts the management of a public service to the responsibility of a public or private entity, with the remuneration of the management of the service related to its operating results.

[238] An SEM (*Société d'Economie Mixte*) is a public limited company whose capital is mostly owned by one or more public entities (State, local or other public entity). This stake can reach a maximum of 85% of total capital. At least one private entity must hold a stake in the SEM, which may be another SEM.

Figure 46 Broadband infrastructure of local authorities in France



Source: Duroyon (2009)

Furthermore, the NRA published a document on 07.04.2009[239] on the framework of local authorities in the context of optical fibre. As an example, reference is made to the Single-Purpose Intercommunal Syndicate for Cable Television (*Syndicat Intercommunal à Vocation Unique pour la Télédistribution - SIVU*) which expects that, by 2012, four towns (Cappelle-la-Grande, Coudekerque-Branche, Fort-Mardyck and Saint-Pol-sur-Mer) will be equipped with optical fibre, through the development of a project with an associated investment to order of 22 million euros, whereas it is expected that fibre will reach the homes of around 60 thousand inhabitants (approximately 28.3% of the population of the urban communities covered).

In reaction to the NGN strategy proposed by ARCEP, various representatives of rural area authorities raised concerns about the development of fibre in sparsely populated areas, which were left out of the strategy proposed by the regulator.

[239] http://www.arcep.fr/fileadmin/reprise/dossiers/fibre/role-collectivites-fibre-thd-070409.pdf.

Accordingly, a senator and mayor submitted a draft law (*La lutte contre la fracture numérique*) to facilitate the planning, organization and financing of fibre infrastructure in sparsely populated areas, which came to be adopted on 05.12.2009.[240]

In terms of regional developments, note is made of the THD92 operation project, launched in 2004. This is a very high speed optical fibre network (which should provide end-users with speeds between 100 Mbps and 1 Gbps). It is located in Hauts-de-Seine (Where the population has the highest average level of per capita income of any Department in France) and managed by the company Sequalum (owned by Numéricable (80%), Eiffrage (15%) and by LD Collectivités (5%)), which won the public service concession for a period of twenty-five years. It is noted that Sequalum will make use of some existing infrastructure of FT and Colt, and will not directly provide retail services directly.

An investment of 422 million euros is planned over the next six years. This project will cover the entire Department, including non-profitable areas. This translates into the target of passing at least 828 thousand homes (including 423 thousand homes in the first three years of implementation and 405 thousand homes over the following three years) and connecting 573 thousand homes.

Following concerns expressed by operators of competing networks (e.g. FT and Colt), related to alleged overlap with existing networks, distortion of competition and misuse of public funds due to the financing of THD92, a complaint was lodged with the EC.

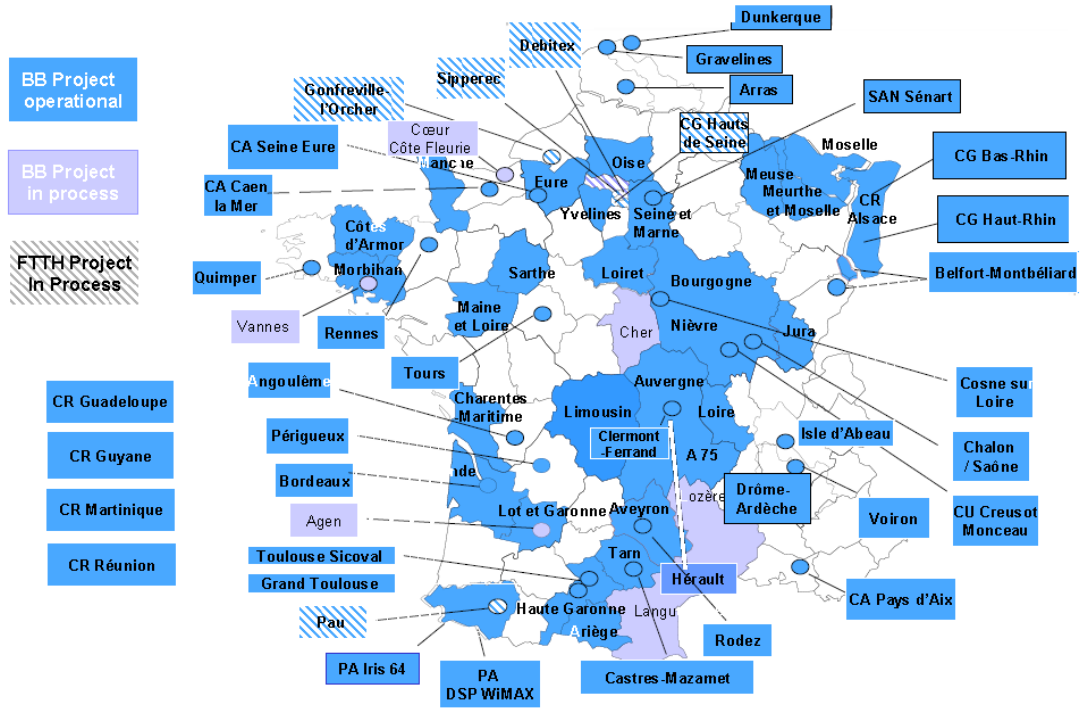
However, the EC gave approval to public co-financing of 59 million euros for the THD92 project - seen as a way to connect homes that are considered difficult to reach, even though most of the area of Hauts-de-Seine has good broadband infrastructure[241] - considering that the allocation criteria are in accordance with the case law of the European Court of Justice.

Figure 47 gives an overview of the investment in broadband in France, summarizing the results obtained from the involvement of various agents in the market, and as a result, for the first time in 2009, France was reported among the countries with FTTTH/B+LAN penetration exceeding 1%.

[240]http://www.assemblee-nationale.fr/13/dossiers/fracture_numerique.asp and http://www.senat.fr/petite-loi-ameli/2009-2010/138.html.

[241]http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1391&format=PDF&aged=0&language=EN&guiLanguage=pt and http://ec.europa.eu/community_law/state_aids/comp-2008/n331-08.pdf. http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1391.

Figure 47 Broadband investment in France (June 2009)



Source: IDATE (2009)

An investment was announced by the French government in January 2010 of around 4.5 billion euros, which will be administered through a new fund for the digital economy. Of this investment about 2 billion euros is to improve high-speed networks and 2.5 billion euros to support the development of innovative content and services to the customer.[242]

The 2 billion euros to improve high-speed networks in the country is included in a national programme to boost the economy through infrastructure investment. The plan is to provide operators with funds (at low rates of interest) to expand their high-speed Internet access networks in order to encourage the development of optical fibre networks outside the major cities and reduce the current inequality in access to Internet services.

Under the proposed system, the electronic communications groups of FT, SFR and Vivendi will be encouraged to invest together to build optical fibre networks, thereby ensuring that no operator has a network monopoly in a given area. These operators have conducted tests in three towns on the outskirts of Paris as to how to share access to optical fibre networks.

242 http://online.wsj.com/article/SB10001424052748704541004575011113378158220.html?mod=WSJ_Tech_LEFTTopNews

However, on 10.12.2010, Bouygues and SFR announced a co-investment agreement for the deployment of optical fibre networks in municipalities located in very densely populated areas in France.[243]

SFR is going to modernize the 2G network in rural areas in order to support HSPA+, with the aim of sharing the network with Orange and Bouygues Telecom after its modernization. This will be the first HSPA network to be deployed in the 900MHz GSM spectrum. France was among the first countries to permit this reorganization of the 900MHz GSM spectrum, with a view to universal broadband coverage. Compared with the usual 3G frequency bands, the GSM 900MHz band supports a longer range and greater signal penetration inside buildings, requiring a smaller number of cells (base stations); this enables coverage of rural areas at a significantly lower cost than is the case of frequencies currently used for 3G.

In parallel, on 03.12.2010, ARCEP announced the preparation of a tender for the allocation of frequency bands of 800 MHz and 2.6 GHz for use in very high-speed "4G" mobile networks; It is expected that this process will have been completed within the first half of 2011.[244]

To cover the more remote areas of France, a satellite will be developed over the next four years to enable high-speed Internet access.

In addition to issues of NGN development, the government has also called for the emergence of a low cost Internet connection, at around 20 euros per month for less well off households, compared with current prices at around 30 euros.

In this context, on 26.01.2010, the French government launched a public consultation on the "ultra-fast" national broadband programme (*Consultation Publique sur le Programme National "Tres Haut Debit")*[245]*,* seeking to compile the opinions of various stakeholders on the implementation of "ultra-fast" broadband in France.

Currently, the French government's goal is to ensure NGA coverage of 70% of the population in 2020 and of the entire population in 2025.

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243 http://www.arcep.fr/index.php?id=8571&L=1&tx_gsactualite_pi1[uid]=1339&tx_gsactualite_pi1[annee]=&tx_gsactualite_pi1[theme]=&tx_gsactualite_pi1[motscle]=&tx_gsactualite_pi1[backID]=26&cHash=949495f5aa

244 http://www.arcep.fr/index.php?id=8571&L=1&tx_gsactualite_pi1[uid]=1336&tx_gsactualite_pi1[annee]=&tx_gsactualite_pi1[theme]=&tx_gsactualite_pi1[motscle]=&tx_gsactualite_pi1[backID]=26&cHash=582663b88c

245 http://www.telecom.gouv.fr/fonds_documentaire/consultations/10/consthd.pdf.

On 25.02.2010 in its presentation of results, FT announced that it would reduce its investment in DSL in dense areas, as well as the deployment of FTTH, until it received regulatory clarifications on NGN.

On 26.02.2010, Orange announced that in the coming weeks it would launch a "*quad-play*" service, including broadband Internet, voice, television and mobile services, with a starting price of 45 euros per month.

As noted, NGN development in France, has some similarities with the Portuguese model, especially in terms of the regulator's focus on enabling access to ducts and to the fibre pooling point by OAO, on developing regionally-based NGN programs with the involvement of local communities and the government's commitment to fostering NGN development.

4.7 Greece

In May 2008, ATKearney and Planning, SA concluded an NGN business model, commissioned by the Greek government, with a view to formulating guidelines for development of high-speed broadband in rural areas; meanwhile a public consultation was launched in the same month on the national strategy for broadband in the period 2008-2013. This consultation is focused on the one hand, on the development of FTTx in the regions of Athens and Thessaloniki, and, secondly, on the implementation of this technology platform in rural areas.

It was concluded that it was unlikely that any model would be viable outside major urban centres such as Athens (where in 2017 coverage is expected to reach 89% of FTTH passed homes - or 1.1 million homes) and Thessaloniki (where in 2012 coverage is expected to reach 97% of FTTH passed homes - or 264 thousand homes), and that even in such centres, to promote the business case, it would be advisable to take advantage of the capillarity of the drainage network and the sharing of the gas and electricity distribution network to install fibre, reducing the cost of its deployment. In both cities, the *"take up"* should be between 45% and 48% of passed homes.

The government-backed plan aimed to connect (via a passive FTTH infrastructure) two million homes and businesses in fifty-two towns and cities, supported by a PPP, where the state would bear 1/3 of total costs estimated at 2.1 billion euros. More specifically, the total costs for the State would be about 700 million euros (a payment is foreseen of 350 euros per passed house and unspecified financial incentives for owners of houses and buildings to facilitate vertical cabling in buildings).

Greece, which has about 3.7 million family households, would be divided into three regions, each with 700 thousand customers, covering at least the main urban areas. The operation of each of these areas would be the object of a concession by the State, made in the second half of 2009 for a period of thirty years, upon the conclusion of which contract, the concession shall revert to the state. The wholesale prices (charged for dark fibre and the co-location of space) and the objectives of additional coverage shall be important criteria in the selection of the concessionaires.

The investment model chosen fulfils the following conditions:

a) Creation of a open access model network (*1st layer*) for providers of electronic communications services;
b) At least 100 Mbps downstream speed for the user;
c) Dark fibre network based on the passive infrastructure model;
d) Private exploitation of the passive infrastructure for thirty years;
e) Seven year deadline for the project's completion.

It was expected initially that the project would get off the ground in the second half of 2009 and that the connections would have a point-to-point architecture. However, Greece's Infrastructure and Networks Ministry announced that the National FTTH Plan, while remaining a top priority, would be postponed, hoping that deployment would begin at the end of 2011.

It should be taken into account that, under the "Digital Strategy 2006-2013"[246], launched previously by the government and financed by *"Operation Programme Information Society",* the deployment of optical fibre in metropolitan areas was already planned in seventy-five towns and cities - municipal capitals and other major cities (except Athens and Thessaloniki).

The objective of this program (which covers an estimated 2.4 million people) is to connect three thousand websites of public interest entities (universities, museums, libraries, etc.) and to provide citizens with faster and easier Internet access, especially in rural areas. At the same time, certain municipalities began offering wireless broadband services to their citizens, although the impact is not comparable to either of the two projects described above.

Looking at the case of Greece, it is clear that the government understood the need, as in Portugal, to liaise with operators in promoting investment in NGA outside major urban

[246]http://www.mnec.gr/export/sites/mnec/en/press_office/DeltiaTypou/Documents/2008-01-28_FactSheetOnDigitalGreece.pdf.

centres. Moreover, in both cases, it is clear that importance is attributed to the openness of concession networks to third parties, to the existence of high reference speeds and to coverage objectives.

4.8 The Netherlands

In the Netherlands, in late 2005, KPN announced its plan for migration to *"All-IP"* (generally FTTH in new constructions and FTTC in old buildings) by 2010, disposing of almost all exchange buildings, with the "dumping" of the OAO co-located therein.

As such, OPTA launched a public consultation in May 2006 on *"All-IP"*, with the result, published in October 2006, leading to the initiation of a market analysis for LLU, WBA and *backhaul* at SDF level.

In January 2007, the report *"The business case for sub loop unbundling in the Netherlands"*, made by Analysis for OPTA, confirmed that deployment of SLU was largely restricted by high costs and economies of scale (even considering a possible reduction in co-location costs) and by negative cash-flow (compared to the current situation with provision of LLU-based services).

Therefore, in March 2007, OPTA (the Dutch NRA), acting as a "catalyst", asked KPN to negotiate a transparent and non discriminatory solution with the OAO, obtaining the following commitments from the biggest *"players*":

a) Deactivation of MDF with co-location only from 2010;
b) Maintaining access to MDF at 138 Metro nodes and in 59 additional locations. The conditions of access to MDF include the possibility of covering 50% of households using "mini-MDF", with current prices remaining in place until January 2013;
c) KPN will finance the costs of migration to mini-SDF, WBA and SDF-level access;
d) KPN will pay compensation to the OAO for leaving MDF buildings;
e) The WBA offer will emulate the functionality of access at MDF level.

The plans to transform KPN's network illustrate a radical change from a traditional network to an *"All IP" network*, with simultaneous investments in the network core and in the access network. The main consequence of this large-scale transformation for the OAO is the disappearance of MDF and a major reorganization of the interconnection points.

KPN offered two alternatives to those operators which decided to leave the MDF voluntarily: unbundling at sub-loop level or a next generation WBA *bitstream product* where unbundling

is carried out at the logical level (virtual LAN with the possibility of defining QoS characteristics).

OPTA preferred that the service providers enter into direct agreement in matters pertaining to compensation due to the clearance of MDF and conditions of access to the SDF. A strong incentive was provided by the NRA's consideration of these agreements between operators in its review of the market analysis.

In November 2008, OPTA notified the EC of its analysis of markets 4 and 5, in which the problems associated with the "unbundling" of fibre (FTTH) and WBA (FTTC) were highlighted, whereby, essentially, the first component is regulated and the second only with regard to services for business customers.

The regulatory measures outlined included the application of a price cap on the unbundled offer of the fibre loop, based on projections of a reasonable business case and reflecting the specifics of the risk associated with investment in fibre. In this case, the weighted average cost of capital is reviewed every three years by OPTA, considering a risk premium inherent to investment in fibre and to the application of asymmetric regulation measures.[247]

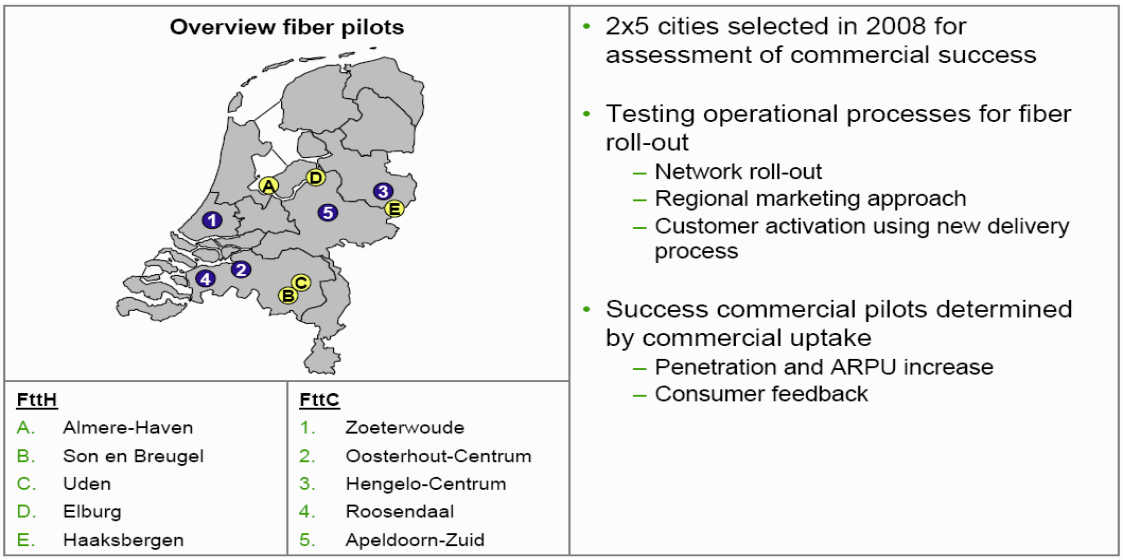
Currently, planning of fibre deployment is carried out jointly between KPN and Reggefiber (originally of the Amsterdam area) in order to accelerate the deployment of point-to-point FTTH, which should be concluded within seven years. It is noted that in 2008 both entities combined their FTTH related activities in partnership with "Reggefiber FttH" (41% owned by KPN and 59% by Reggefiber), with the approval of OPTA and the Dutch Competition Authority.

KPN/Reggefiber provides retail offers, based on point-to-point FTTH, with speeds of up to 100 Mbps, while there are several packages of services (including broadband, television and voice).

meanwhile, since the second half of 2008, KPN has conducted at least ten commercial tests of fibre (including five towns with FTTH and with five others with FTTC - see Figure 48) capable of offering speeds of up to 30 Mbps and enabling coverage of around 450 thousand passed homes at the end of the third quarter of 2009.

[247] http://www2.opta.nl/download/202874+Policy+rules+tariff+regulation+fibre%2Epdf.

Figure 48 KPN fibre pilot projects



Source: KPN

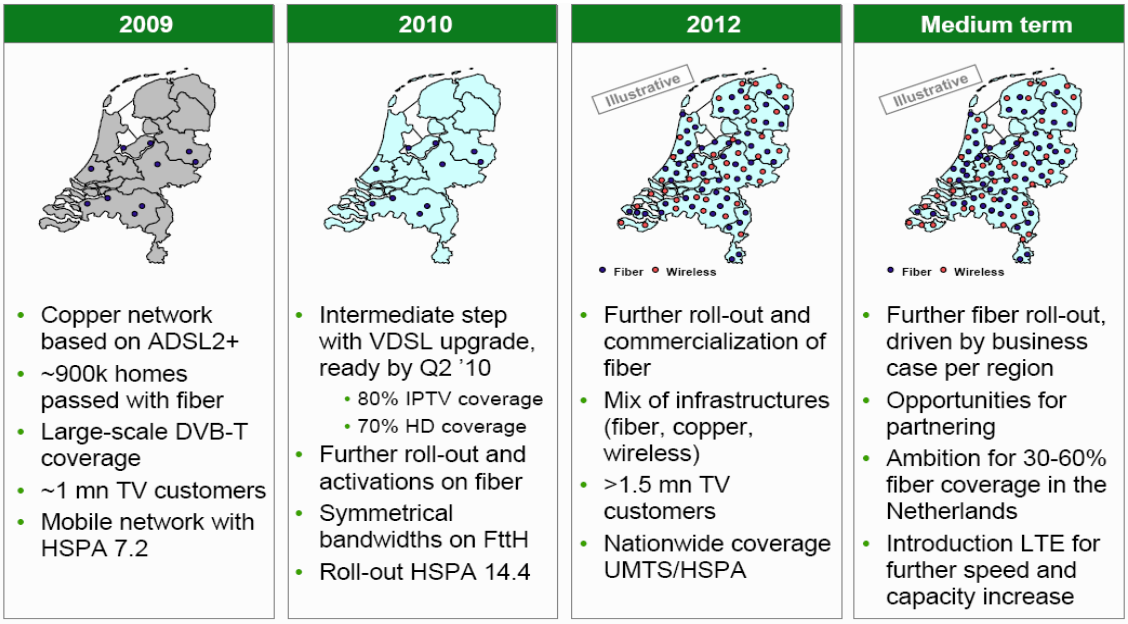
Tests have shown the need for KPN to expeditiously restructure its "*back-office" systems*, which in relation to the activation of fibre customers has only functioned in manual mode and therefore can meet no more than 800 orders per week, when it should be able to satisfy 5 thousand orders per week.

In this context, KPN contracted Alcatel-Lucent Bell Labs for the provision of consultancy services regarding the modernization of the network but also with regard to resulting strategic and commercial implications.

The goal of Holland's historic operator, in terms of FTTH, remains to achieve coverage of between 1.1 and 1.3 million passed homes in 2012 and 460 thousand homes connected at the end of 2012, whereby it would achieve a coverage rate of 5.5% in terms of passed homes as soon as 2010. In terms of FTTH and FTTC, taken together, the target for the end of 2012 is to reach between 600 thousand to 800 thousand passed homes, which corresponds to about 10% of total households; while over the medium term KPN expects to connect between 30% to 60% of households in the country[248] (see Figure 49).

[248] http://www.kpn.com/corporate/en/ir/Update-Fibre.htm.

Figure 49 Development prospects of the KPN network



Source: KPN

However, in the past concerns arose as to the viability of KPN's FTTC+VDSL2 business case[249], even while KPN considers that the monthly ARPU of its FTTH (between 65 euros and 110 euros) and FTTC (between 45 euros and 75 euros) customers justifies the investment, with an estimated average ARPU at 60 euros per customers signed up to triple play bundles of services and 40 euros for a package of voice and broadband.

It is noted that the estimation of investment in FTTH is, according to data from KPN (released on 15.12.2009) from 700 euros to 800 euros per passed home, plus more than 200 euros per connected home (which includes the optic termination unit) and an additional 400 euros per active "triple play" customer (which already includes the equipment to be installed at the customer's premises). The comparable figures for investment in FTTC are, respectively, from 150 euros to 200 euros, 100 euros to 150 euros and 400 euros.

Among KPN's competitors, note is made of UPC and Ziggo, both cable networks operators, which have been adopting HFC solutions, with retail offers at speeds of up to 120 Mbps and 50 Mbps respectively.[250] The coverage objectives of UPC and Ziggo in terms of passed homes are 35% and 55% respectively. It is also expected that Tele2 will be able to achieve coverage of two million households with VDSL2 in 2011.[251]

[249] http://www.telecompaper.com/news/article.aspx?cid=688349.

[250] Ziggo plans to increase these speeds up to 100 Mbps in 2010.

[251] http://www.telecompaper.com/news/article.aspx?cid=688349.

Note is also made, in Amsterdam, of the Amsterdam Citynet PPP[252], which renewed and developed a network of ducts and point-to-point dark fibre, selling access to service providers, which will facilitate the development of offers of retail broadband services.

Following an enquiry launched in the previous year, the municipality of Amsterdam concluded in 2002 that an open network of fibre was the best, safest, and fastest solution, and also the most *"future proof",* to satisfy the needs of citizens and companies, establishing an advisory committee to define the way forward. In 2003, this committee reported that a PPP would be the best solution in technical and financial terms, resulting in the launch of an international tender in 2004 for the selection of partners and, in 2005, auctions for awarding the construction of the network and its operation.

As such, in 2006, the GNA CV consortium was established (which involves the municipality and eight private investors, including BBned, a subsidiary of Telecom Italia) and construction of the network was begun in a part of the city (ZZeeburg, Oost-Watergraafsmeer and Osdorp) which covers 40 thousand residential households and business (about 10% of the city's total). The first connections were made in 2007 and the project remains ongoing.

The cost of connecting approximately 40 thousand homes totalled around 30 million euros, of which 18 million came from equity (divided equally between the city council, private investors and real estate companies) and 12 million in loans.

This partnership was the target of a thorough investigation initiated in 2005 by the EC's Directorate General for Competition, to ensure that it did not result in state aid (making sure in particular that the municipality of Amsterdam was investing according to market conditions and that various private entities were also significantly invested in the project). The EC concluded that in case of economic losses, these would be incurred by the private partners under the same conditions as the council and therefore the investigation was closed in December 2007.[253] On that occasion, the EC also warned that it was not enough for municipalities to demonstrate that they are investing as a "normal" investor, it Is also essential that there is significant private investment in a project and that a good investment plan is evident.

One of the most successful case studies in terms of FTTH deployment in a community is that of the town of Nuenen, located in the southern Netherlands, with about 8 thousand homes and 25 thousand inhabitants, with one quarter of these aged over 65 years.

[252] http://www.citynet.nl/.

[253] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/07/1889&format=HTML&aged=0&language=EN&guiLanguage=en.

Originally, the local community[254], aimed to provide its elderly members with a video service. Following discussions inside the community on how best to respond to this need, *OnsNet*, a co-operative company, was established in 2003 with the aim of developing a high-speed Internet network in the town.

As such, an open access network was deployed with point-to-point architecture and with two fibres per household. Trenches were opened, extending about 150 km and making use of 3 thousand km of fibre. The cost of deploying fibre is reported at about 1470 euros per household, and the network took six months to construct. Since there was no interest from a single provider of electronic communications services, the residents' association also set up an ISP.

This project was co-financed by the Dutch Ministry of Economic Affairs which agreed to provide the service free for a year, equivalent to 800 euros per residence. This measure had a strong impact by encouraging take-up of the network, which is reported at 97% - virtually all buildings in the city are interconnected, and it is therefore the community with the highest density of fibre in the world. Later, the network spread to neighbouring villages, without government support.

OnsNet owns 95% of the network, whereas a board, consisting of local residents elected by the community, remains responsible for supervising *OnsNet.* All functions relating to the business, including maintenance, are outsourced.

It is considered that, apart from the obvious differences in terms of the markets' economic potential, there are important aspects shared between the Dutch case and the Portuguese case, such as regulatory concern in making sure that migration from traditional networks to NGA networks is undertaken without adversely affecting competition and end-users and such as strong competition between different technological platforms, resulting in more rapid NGA deployment.

4.9 Italy

Italy has projects for the development of very high speed broadband in a regional, municipal and provincial context, whereas the government is responsible for implementation of sectorial policies and for regulating the technical implementation of defined policies.

[254] In the original *"Local Housing Corporation"*.

The government's strategy is to ensure population coverage by the end of 2012 with speeds of 2 Mbps and 95.6% of the population with speeds of 20 Mbps, which will involve a total investment of 1.5 billion euros.

Italy also shows a high level of dependency on xDSL technologies in the provision of broadband services, with only small metropolitan areas having alternative networks to that of the historic operator (Telecom Italia - TI).

In this context, the government and the major operators[255] signed a memorandum of understanding on 10.11.2010 for the establishment of a PPP in order to deploy passive NGA infrastructure, including ducts, dark fibre and cabling in buildings. These infrastructures, to be developed where the operators are unwilling or unable to invest independently, are likely to cover about half of Italian households.

It is noted that, previously, partnerships existed, albeit narrower, between operators to develop optical fibre networks.

For example, in May 2007, TI established a partnership with Metroweb[256], with a view to expanding its optical fibre network in the metropolitan area of Milan, giving TI access to 70 thousand buildings. This agreement included an investment of about 50 million euros and the right to use the infrastructure for 15 years (renewable for a further 15 years). TI uses its own infrastructure and infrastructure made available by Metroweb to offer broadband, including VDSL, up to 50 Mbps.

In another example, in light of the increased costs of local loop unbundling imposed by TI, Fastweb (major fixed network OAO, which plans to invest a total of more than 3 billion euros in NGA) and Wind[257] established a sharing agreement in August 2009 to reduce the cost of co-location and rationalize investment, encompassing the following major aspects[258]:

a) Sharing of co-location of space and of backhaul capacity in a number of selected TI exchanges, in relation to LLU;
b) Fastweb facilitates access to its ducts, dark fibre and transmission capacity in areas covered by its network.

[255] IT, Fastweb, BT Italia, H3G, Tiscali, Vodafone and Wind.

[256] http://www.lightreading.com/document.asp?doc_id=125260.

[257] This operator offers *triple play services*: telephone, internet and TV. See http://www.wind.it/it/privati/index.phtml.

[258] http://www.company.fastweb.it/files/14/FASTWEB_2Q_09_RESULTS_SLIDES.pdf and http://www.fiberevolution.com/2009/08/wind-and-fastweb-sign-unbundling-and-ftth-network-sharing-deal.html.

The Broadband Monitor[259], set up on joint initiative of the Executive Broadband Committee (under the supervision of the Ministry of Technology and Innovation and the Ministry of Communications), aims to monitor the availability of infrastructure and services in Italy. Meanwhile, the Italian NRA (AGCOM), created the NGN Italy Committee on 13.02.2009 [260], an advisory body that issues opinions and proposes solutions concerning technical aspects, when requested by AGCOM.

According to the latest data available from IDATE, with reference to December 2009, Fastweb has reached two million passed homes, compared to 100 thousand homes passed by the historic operator and 93 thousand by municipal, regional or provincial entities. According to the FTTH Council of June 2010, about 1.6% of homes in Italy were connected, placing the country in eighteenth position worldwide out of twenty-three countries.

Italy has 23.9 million households and, according to the 2008 annual report of AGCOM, there were 277 thousand fibre connections in Italy (the vast majority of Fastweb).

Metroweb owns the largest fibre network in strategic areas such as Milan and Valtellina. It operates as an open access provider offering infrastructure to third parties such as ISP providers, providers of telephone services including mobile, government agencies and other content distributors.

The investment planned by TI in FTTX, between 2007 and 2016, totals 10.4 billion euros (see Figure 36), distributed as follows:

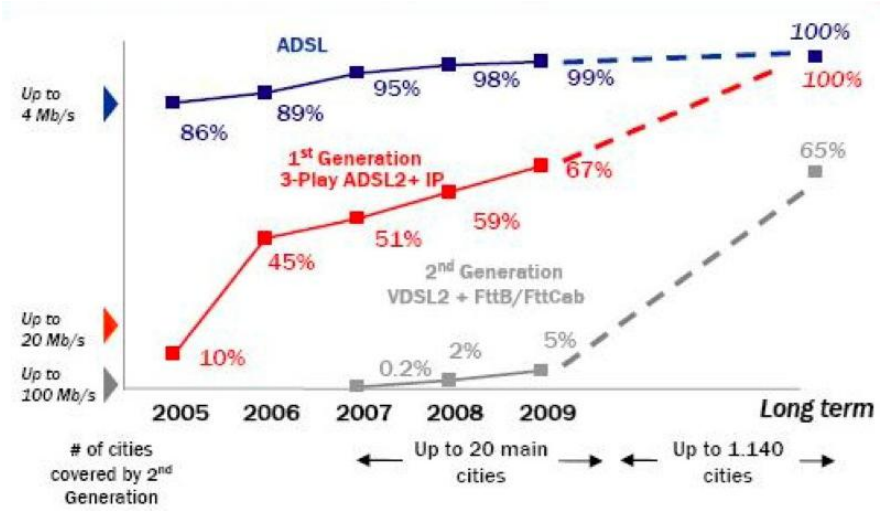
a) 4.6 billion euros to complete the first generation NGN platform (ADSL2+, FTTX);
b) 5.8 billion euros to complete the second generation NGN platform (FTTX), covering 1,120 to 1,140 municipalities (starting in Milan), 2,210 NGA exchanges, 13 million customers (65% of the population) and investment in FTTE (*Fibre To The Enclosure)*[261] and VSDL2+;
c) 20 billion euros estimated for a network that is entirely FTTX.

[259] http://www.osservatoriobandalarga.it/.

[260] http://www.agcom.it/default.aspx?message=viewdocument&DocID=3029.

[261] Fibre up to a determined point located on each floor in a building with several floors.

Figure 50 Evolution of NGA investment planned by TI



Source: Quintarelli (2008)

The objectives of TI for 2009[262] for development of FTTX (ADSL2+, FTTCab+VDSL2, FTTB+VDSL2 and FTTH) were as follows:

a) Coverage of the entire expanse of Milan;
b) Beginning of coverage of Rome with second generation NGA;
c) 250 thousand new homes cabled with FTTH;
d) Agreement with other operators to pass fibre.

On 15.05.2009, a report commissioned by the government from Francesco Caio consultants was delivered[263]. Looking at the situation in Italy in the context of NGN, the report, while not released, is known informally as *the "Caio Report"*, and it was conducted to prepare the optical fibre development strategy in Italy.

The report suggested two main models for the rapid development of high-speed broadband in the country (considered a priority for the government, as referenced in AGCOM's 2009 Annual Report)[264], namely:

a) Creation of a hybrid network of integrated fibre and copper to ensure high speed to 50% of all housing, budgeting this project at about 10 billion euros over a period of five years;
b) Development, over a period of four years, of a fibre network with coverage of 25% of Italian households - a project estimated to cost about 5.4 billion euros;

[262]http://www.regione.piemonte.it/innovazione/images/stories/innovazione/B3/dwd/burzio1105.pdf.

[263] This author was also hired by the British government to conduct a similar study on NGA in the United Kingdom. See http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/d/caiofinal_120908.pdf.

[264] http://www.agcom.it/Default.aspx?message=visualizzadocument&DocID=3241.

c) In this context, on 07.06.2009, the Chairman of AGCOM suggested that the Italian government found a company, with public and private capital and with participation of industry and business leaders, to develop optical fibre network.

On 04.11.2009, the EC published its response to remedies proposed by AGCOM in respect of markets 1[265], 4 and 5. The remedies at the wholesale level to be imposed on TI (approved by AGCOM in their final version in January 2010), included the Wholesale Line Rental - WLR offer), unbundled offer of the local sub-loop (applied to copper loops), access to ducts and to dark fibre and bitstream access on the copper and fibre network.

Bitstream access at *DSLAM* level and wholesale line rental are compulsory impositions only in areas not open to full unbundling of the local loop and of shared access.

AGCOM has not imposed unbundling of the fibre loop, arguing that this would not be suitable at the very initial stage of fibre development in Italy.

Among the recommendations made by the EC, the following are of particular note:

a) Treatment of the formal commitments of TI - Although TI's commitment strengthens the obligations of non-discrimination in the provision of wholesale access to the network to services, where TI is the SMP operator, the EC proposed that TI follow the example of the Polish historic operator with respect to the access model (which based its commitment on *"equivalence of outcomes"* EOO)[266];
b) Price of access to ducts and dark fibre - The EC regretted that AGCOM had not imposed an obligation of cost orientation in relation to the prices for access to ducts and dark fibre, considering that this would result in delays in investment in fibre networks by competing operators;
c) Fibre loop unbundling and migration to NGA - The EC recommended the imposition of the obligation of access to the unbundled fibre loop, regardless of the architecture and technology used by TI and, at the same time, sought the introduction of regulatory measures regarding the alternative operators' migration process from copper-based products to NGA products. It was also sought of AGCOM that the next analysis of wholesale broadband markets consider further recommendations from the EC.

On 07.05.2010, a national project was announced by three operators - Fastweb, Wind and Vodafone Italia - to develop an NGA network, with a point-to-point architecture. The network

[265] Market 1 - Access to the public telephone network at a fixed location for residential customers..

[266] The EOO model is based on the regulation of wholesale products, processes and prices, so that the offer to alternative operators can be comparable to, although not exactly the same as, that of the historic operator.

will be open to other service providers including the historic operator, which may join the investment project, if they see fit.

The first phase has a duration of five years and provides for a deployment of NGN in Italy's 15 largest cities. The total population of these 15 cities amounts to about 10 million people and nearly 4 million homes. Investment is planned to total 2.5 billion euros, leading to a cost of 600 euros per household, below the normal average price per household (around one thousand euros per household), largely due to infrastructure already in Fastweb's possession.

This investment began with the launch of a pilot project in the area of Collina Fleming (Municipality of Rome) with a view to connecting about 7 thousand homes through this new network by mid 2010. In addition to the financial contribution, the promoters of this project have agreed to migrate their customer base to this new NGA network.

The second phase of this project provides for a total investment of 8.5 million, and aims to expand it to towns and cities with more than 20 thousand inhabitants, comprising approximately 50% of the Italian population.

With regard to rural areas, where existing broadband infrastructure has been insufficient to meet the needs of citizens, the Italian government has outlined two initiatives.

The first initiative is to provide, in about 2 thousand municipalities (which constitute "white areas" in which modem broadband infrastructure remains non-existent), using public procurement, the deployment of optical fibre backhaul infrastructure, enabling the delivery of retail broadband services with a downstream capacity of at least 20 Mbps.

The second initiative results in a guarantee, when terrestrial backhaul is impractical, of connection to broadband using other means, with financing for decoders, modems and satellite dishes for satellite communications.

Total public investment - whose compliance with community legal rules was confirmed by the EC in April 2010 - for both initiatives is estimated at 154.5 million euros for the period 2009-2015, to be shared between EAFRD and the Italian government, whereas the latter may yet come to contribute an additional amount of 56 million euros.

In Italy, as in Portugal, the strong dynamism of alternative operators is evident when it comes to NGA investment. Notwithstanding that the role assumed by the historic operator in Portugal appears more active than the role taken by TI. In both cases, it is also evident that

the respective NRA attribute great importance to access to ducts and NGA deployment in rural areas is deemed as key.

However, the model followed by AGCOM for global deployment of NGA (essentially a network "cooperative" with public and private capital) could result from specific circumstances which do not appear applicable, at the current state of development, in Portugal, also considering the concession model established for rural areas.

4.10 Japan

The experience of Japan, such as, for example, Singapore, takes place in a context which does not fit well with the national experience, particularly given the high degree of verticality in construction in these countries - which substantially reduces the costs of deployment - and due to the particular relationship between government and large conglomerates ("*Keiretsu*") at multiple levels, including the channelling of investment, and the organized manner of State intervention in private projects of public interest - which would be inconceivable in the EU context.

This set of conditions is generally perceived as having contributed decisively to putting Japan at the forefront of FTTH deployment, both in terms of the number of subscribers and also in terms of affordability.

In general, the basic principles followed by the government in this country with about 128 million inhabitants, with the aim of achieving broadband coverage of 100% and fibre coverage of 90% throughout the national territory as early as 2010, are based on:

a) The supply of broadband services by private operators, supported by government policies designed to encourage healthy competition, incentives to business investment (e.g. interest rate subsidies, tax exemptions and subsidies) and technological neutrality;
b) Ongoing efforts to encourage subscription and use to stimulate new demand;
c) Promotion, particularly in rural or remote areas, of coordination between users, government and municipal authorities, notably with respect to the opening of local public fibre networks and the award of grants and tax exemptions.

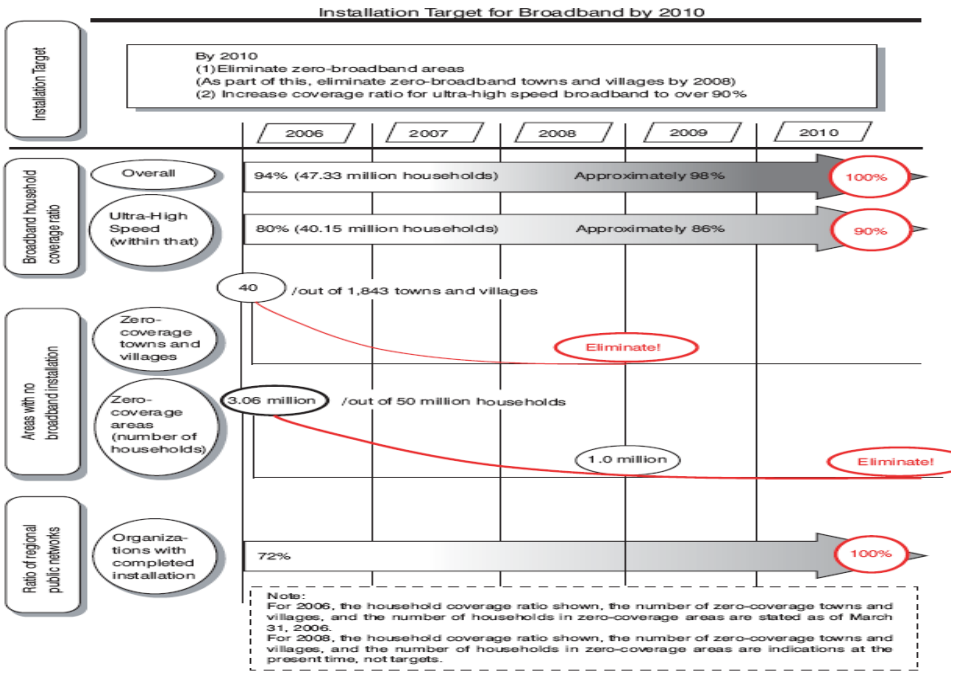
This is in a context where, according to OECD data, the penetration of broadband subscribers was 26.3 subscribers per 100 inhabitants as of June 2010, and particularly where penetration of fibre (with 14.6 subscribers per 100 inhabitants) far exceeded that of DSL and cable (with 7.3 and 4.2 subscribers respectively per 100 inhabitants).

One of the key concerns present in the strategy of the Japanese government, established in 2006 (see Figure 51), has been to combat the "digital divide", particularly because this country has seen a massive depopulation of rural areas coupled with a rapidly aging population, whereby broadband is deemed essential to the revitalization of these areas.

It is noted that Japan was the first country which decided to regulate access to fibre, whereby NTT was obliged to provide an unbundled offer of the fibre loop, from April 2001, with prices subject to regulatory approval.

In establishing pricing for fibre LLU, the regulator considers a model of "prospective real costs", the trend in costs over the past seven years and expected profit margin.

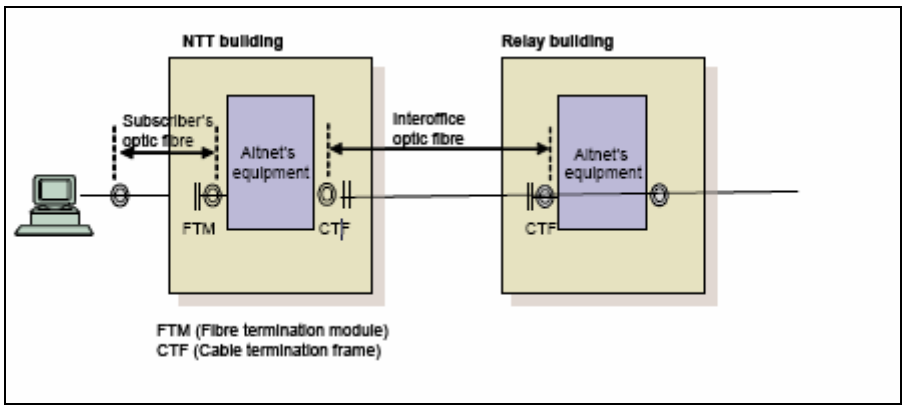
Figure 51: Japanese government's broadband strategy



Source: Ministry of Internal Affairs and Communications

Figure 52 illustrates the configuration of the NTT East and NTT West fibre network for the provision of the unbundled offer of the fibre loop to alternative operators.

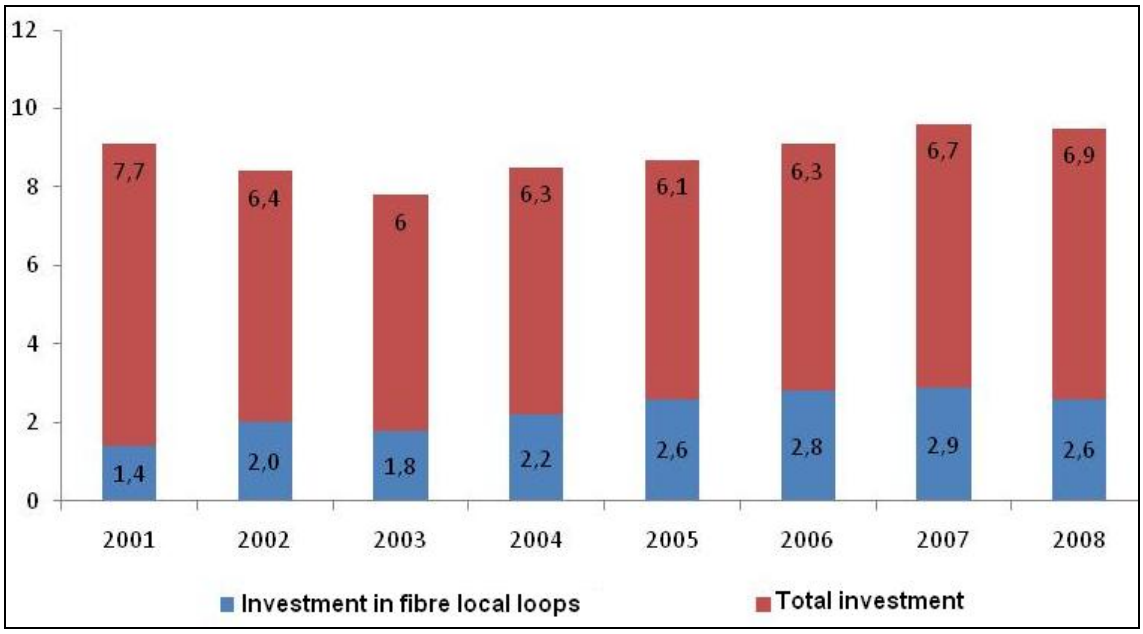
Figure 52 Configuration of NTT East and NTT West Network for fibre LLU



Source: NTT

NTT, with a market share approaching 50% in broadband, is the operator leading the deployment of FTTH in this country, achieving a market share of around 74% in this segment. Figure 53 shows NTT's investment in fibre and total investment in equipment for the period 2001-2008.

Figure 53 NTT Investment (€ bn)



Source:ICP-ANACOM, based on data from Ovum Consulting (2009b)

One of the most recent relevant developments in NGN came with the announcement[267] by NTT West, on 28.02.2008, of the "Flet's Hikari Next" service based on NGN, including VoD, videophone and DTT[268] over IP, "in collaboration with partners in different fields and industries." Deployment will have begun in late March 2008 in certain areas of the Osaka

[267] http://www.hemscott.com/news/rna/detached.do?id=60917668853199.

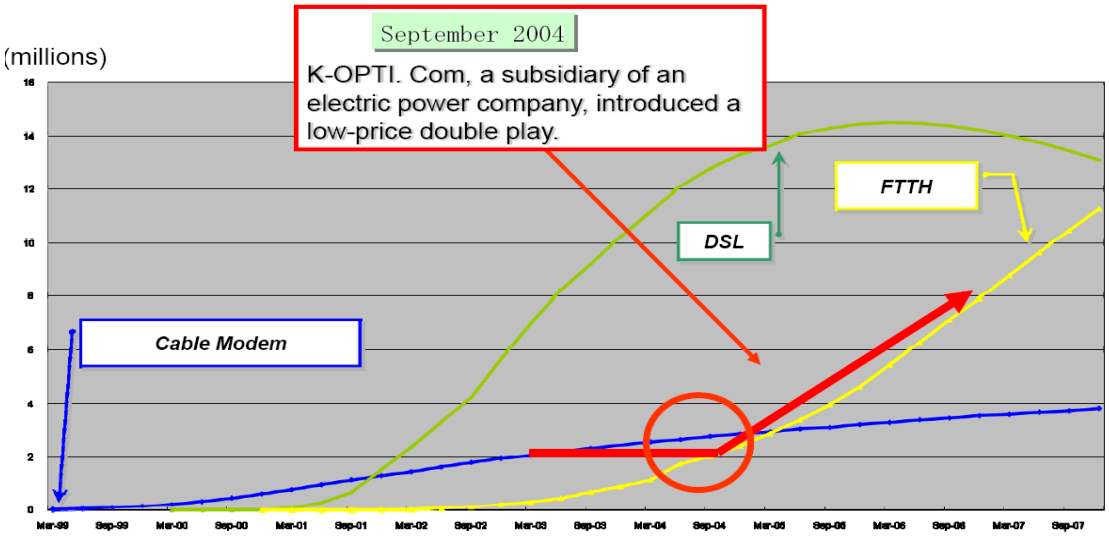
[268] *Digital Terrestrial Television*

Prefecture and will be completed, in the entire area served by the operator, by the end of March 2011.

On 29.02.2008, NTT East and NTT West announced[269] plans for a joint investment of 6.2 billion euros[270] in the next fiscal year, with about 13% in NGN, quadrupling investment in NGN over the previous financial year. This as part of a total planned investment in FTTH of about 37 billion euros between 2004 and 2010, reaching 47 million households over this past year.

However, competition induced by the entry of K-OPTI (a subsidiary of an electricity distribution company), and currently by the operator KDDI, into the broadband services market, has also contributed to the spread of fibre-based offers (see Figure 54).

Figure 54: Evolution of the offers based on the cable network, DSL and FTTH in Japan



Source: Japanese Ministry of Internal Affairs and Communications

In particular, it is noted that the latter operator has been investing heavily in fibre since 2005, providing for an investment of 350 million euros in fiscal 2009, which represents an increase of 87% over the previous fiscal year.

In January 2010, KDDI announced it would acquire 37.8% of the largest cable operator in the country, JCOM, for 2.9 billion euros.[271] According to this company's chairman, this acquisition is crucial since it will allow KDDI to reduce its dependence on optical fibre infrastructure with respect to its rival, NTT. The agreement gave KDDI access to over 3.27

[269] http://uk.reuters.com/article/technology-media-telco-SP/idUKT12474820080229.

[270] About of 8.5 billion U.S. dollars (exchange rate on 10.02.2010).

[271] About 4 billion U.S. dollars (exchange rate on 10.02.2010).

million customers - including 1.6 million cable subscribers - in addition to its 2.85 million optical fibre and ADSL customers.

It should also be taken into account that the fixed broadband market in Japan seems to be showing some early signs of saturation, since a decline has been reported in customer volumes for the first time, in the third quarter of 2009 (Ovum, 2010b).

It should also be noted that in Japan, aerospace conglomerates are also heavily involved in developing infrastructure for electronic communications and on 23.02.2008 the geostationary WINDS satellite (a joint project between the Japan Aerospace Exploration Agency and Mitsubishi Heavy Industries) was launched from the Tanegashima Space Centre; this satellite will allow users with small aerial dishes to access communications services with a speed of 1.2 Gbps.[272] Because the satellite is 22 thousand miles above the earth, it is possible that latency levels in communications will not facilitate certain interactive applications such as games.

In late 2009, Japan announced the "*i-Japan strategy 2015*", setting a target of 100Mbps for the mobile band and 1Gbps for the fixed band by 2015. The Japanese government also expects that penetration of these services will reach 100% by 2015.

The social, economic, cultural, demographic and government model of Japan is substantially different from the situation in Portugal, although in both cases note is made of the very active role of the State in promoting public broadband policies, in particular in rural areas. Another differentiating aspect between the situations of both countries is the role of the equipment industry, which is very important in Japan.

4.11 New Zealand

In New Zealand, the vast majority of accesses are made via xDSL, with the cable network present only in limited areas of two cities. In June 2010, according to OECD data, broadband penetration was estimated at 24.5 subscribers per 100 inhabitants.

The New Zealand government's plans for ultrafast broadband (*"Ultra-Fast Broadband"* - UFB)[273] initiative are aimed at ensuring the necessary infrastructure that will enable greater productivity, in order to contribute to the growth of the country's economy in line with the following principles:

a) No discouragement or substitution of private sector investment;

[272] http://www.cnn.com/2008/TECH/02/23/japan.satellite/.

[273] http://www.med.govt.nz/upload/70936/FDBI-Submissions-007-Auckland-Region.PDF.

b) Avoid consolidating the position of current broadband network operators;
c) Avoid excessive duplication of infrastructure;
d) Focus on new infrastructure construction;
e) Guarantee of broadband services at affordable prices.

To this end, the New Zealand government considered an investment necessary of 753 million euros[274] (which will be added to private sector investment) in an ultra-fast broadband network with open access covering 75% of the population, making use of two programmes, one for urban areas and another for rural areas.

For urban areas, the Minister for Communications and Information Technology announced the formation, in October 2005, of *Crown Fibre Holdings Limited* (CFH), which will be responsible for managing government investments in optical fibre networks and for the selection of partners for network operations in the thirty-three most densely populated areas, according to a PPP model, creating *"LFC - Local Fibre Companies"*. This organisation will support virtually all investment risks, with the local partner's investment limited to the connection of customers to the network. The model to be followed in the construction of the network will be based on the offer of wholesale services by the LFC at a passive or active infrastructure level.

The government's objective for urban areas is to ensure downstream speeds of 100 Mbps over the next ten years.

The main focus of the government plan for rural broadband (budgeted at 151 million euros)[275] is the installation of backhaul fibre in rural areas and, subsequently, to rapidly connect 97% of the country's rural areas and 97% of schools located in rural areas to broadband. The reference downstream speeds will be 100 Mbps for 97% of schools and 5 Mbps for 97% of households, with remaining schools and homes benefiting from downstream speeds of 10 Mbps and 1 Mbps respectively.

It is noted that Telecom New Zealand - TNZ (New Zealand's historic operator), which is responsible for implementing the rural broadband plan, directly after the establishment of the objectives mentioned above, announced significant losses for the next three years.

In more densely populated areas, local infrastructure is installed by CFH, which subsequently provides a wholesale offer to the LFC. The government will always play a part in LFC investments to ensure open access. It can be assumed that the risk associated with

[274] About 1.5 billion New Zealand dollars (exchange rate on 10.02.2010).
[275] About 300 million New Zealand dollars (exchange rate on 10.02.2010).

demand is borne by the state, whereas the risk associated with building the network is supported by the LFC.

In certain areas, TNZ has already embarked on the FTTH deployment plan, agreed in 2008 in the context of the historic operator's functional separation (implemented only for broadband products and services and NGN). It was in this context that TNZ pledged to construct an NGA network over the next four years, consisting in particular of about 3.6 thousand new street cabinets, connected by 2.5 thousand kilometres of optical fibre.

The investment will be based on TNZ's core network, and the plan should cover all cities in New Zealand with fast broadband by the end of 2012, with 99% of all lines having capacity to reach downstream speeds of 10 Mbps and 50% of lines having maximum downstream speeds of 20 Mbps.

Apart from TNZ, OAO such as TelstraClear, Vodafone, Woosh, Citylink and Vector have also started deploying FTTH.

On 21.11.2009, the Ministry of Economic Development and CFH began a process of selecting partners to follow up on the ultrafast broadband initiative. Investment proposals for one or more areas were submitted by 29.01.2010, and the results of the selection process were announced progressively. As such, on 13.12.2010, there were two contracts approved, four entities selected for priority negotiations and nine other entities placed on a short-list[276].

On 24.05.2010, TNZ announced[277] its intention to undergo structural separation in order to participate in UFB, which could be interpreted as a step towards the future sale of its functional access division, Chorus; this is also because CFH has held talks with the historic operator. The structural separation proposal would involve the creation of two companies, a wholesaler and retailer, each with its own board of directors, CEO, management team and shareholder capital.[278]

The wholesale company resulting from any structural separation will offer wholesale access services to all retail providers, at a national level, both with respect to the copper network and to the fibre network, in addition to providing backhaul services. At the same time, it would manage the process of migrating customers from the copper network to the fibre

[276] http://www.crownfibre.govt.nz/news/press-releases/more-prioritised-bidders-announced-for-ufb-initiative-.aspx.

[277] http://www.telecom-media.co.nz/releases_detail.asp?id=3689&page=index.

[278] http://investor.telecom.co.nz/phoenix.zhtml?c=91956&p=irol-presentations.

network in order to avoid disruptions and increase take-up of fibre-supported services. This company would be barred from providing retail services.

The retail business resulting from any structural separation would compete on an equal footing with other service providers, providing offers related, in particular, to fixed access, fixed voice, broadband, mobile services, to both residential and business customers.

In the meantime, on 14.12.2010, the New Zealand Government announced the beginning of UFB roll-out on the ground with the first deployment of fibre taking place at a school in Whangarei.[279]

The realities of Portugal and New Zealand are different, in socio-geo-demographic and economic terms and in terms of the legal and regulatory framework. Nevertheless, the importance given by the government to NGA deployment in rural areas is noteworthy. Furthermore, New Zealand considers it important to implement functional separation in order to accelerate NGA investment, while in Portugal this evaluation is ongoing in the context of strong market dynamics and present and potential factors which may result in adverse effects.

4.12 United Kingdom

In the United Kingdom, following BT's announcement in June 2004 of the "21CN" strategy of migration to NGN, BT and Ofcom agreed, in September 2005, on the creation of *Openreach* (a BT unit encompassing regulated wholesale services, stemming from the pioneering vertical functional separation of BT) *inter alia*, in order to ensure, *ab initio*, that BT NGN was *"fit for purpose"* for all operators - BT and OAO - avoiding the potential for high costs resulting from changes due to the new network's deployment.

Ofcom has accepted that, with the deployment of NGN, certain obligations such as indirect access could "fall", whereas in September 2005, BT committed to continue providing LLU with "equivalence of inputs" and consult OAO prior to decisions that restrict certain products.

In April 2006, Ofcom launched NGNuk, to act as forum of coordination in which key NGN investors would discuss, research, consider and *"when possible agree"* on the course of NGN in the United Kingdom and communicate the results to other stakeholders of the sector and to the general public. BT, meanwhile, set up Consult21, a voluntary programme designed to consult with industry, in line with the principles of openness, transparency and inclusion.

[279] http://www.crownfibre.govt.nz/news/government-updates/ultra-fast-broadband-rollout-begins.aspx.

In December 2007, Ofcom closed a new public consultation on NGN, with discussion of specific "remedies" for NGN access, comprising the offer of WBA for FTTH architectures and SLU + backhaul in the case of FTTC.

On 22.02.2008, the Government conducted a review to look at the barriers to investment in NGN, seeking to ascertain whether: (a) the EU and UK statutory framework has given Ofcom the necessary powers to establish a regulatory regime which would provide regulatory certainty for investors and sufficiently incentivise new investment and (b) whether it is possible to move ahead to FTTB without having FTTC as an intermediate step.

In April 2008, Ofcom launched a public consultation with a view to sounding out the market on: (a) how to secure adequate, efficient and open investment in new build NGN; (b) the technical standards governing access to new build which might help providers offer better services; (c) means of promoting competition and user interests and of ensuring appropriate regulatory conditions.

Essentially, the NRA says that it has confidence in the ability of market players to define their own technical policies, but wants to know what concrete action is sought from the regulator. It also intends to establish in particular whether it would be useful, in the case of new build, to maintain a set of obligations applying to access (e.g. wholesale line rental, Indirect access) or whether the existence of a wholesale bitstream access product would be sufficient. In the consultation document, Ofcom also sets out, as a preliminary position, that it would not be proportionate to require BT to deploy copper in parallel to fibre in new build deployments solely for the provision of an LLU.

Then on 17.06.2008, Ofcom launched a consultation[280] which, among other things, addressed BT's consultation principles with respect to the deployment of NGN and an obligation on BT to publish its NGN plan of record on a regular basis;

On 14.02.2008, the EC presented its comments to the United Kingdom's notification with regards to the market analysis and assessment of SMP on "Wholesale Broadband Access", not manifesting opposition and stating that both the precedent of geographic segmentation of the broadband market[281] and the principles of the regulatory framework highlighted in these comments provided guidance to all NRA.

[280] http://www.ofcom.org.uk/consult/condocs/variations_bt/variations.pdf.

[281] Four geographic areas were considered: Hull (where Kingston is the sole operator); Market 1 (areas where only BT is present); Market 2 (areas with 2 or 3 "significant" providers); and Market 3 (areas with at least 4 "significant" providers).

Essentially, Ofcom's measures, following the market analysis and assessment of SMP on *"Wholesale Broadband Access",* resulted in BT no longer having SMP in local exchange areas with 4 or more "significant" providers with LLU (where its share is on average 45% - compared to 30% for Virgin and 25% for OAO with LLU), taking account in particular that the conditions of wholesale broadband access and LLU have improved significantly (deemed as being so since the creation of *Openreach*) and also taking account downstream cable substitution in the retail market. Accordingly, Ofcom's final decision on obligations to apply to the *"*Wholesale Broadband Access" market was taken on 21.05.2008[282], deregulating the geographic areas with competition, representing around 70% of the market, according to the regulator.

It should be kept in mind that the EC has stated that simply looking at the number of operators in a given area is insufficient to gauge whether or not the area is competitive, and that, in each geographical area, it is also necessary to address structural and behavioural parameters, such as whether there is general move towards competition, the size of the area, past and prospective market shares, restrictions on market power arising from the actions of OAO based on LLU or cable operators and their pricing strategies.

In September 2008, a set of important documents on NGN was published in the United Kingdom, in particular Ofcom's consultation on *"*Delivering super-fast broadband in the UK". In this document, the United Kingdom regulator favours implementation of "passive access" products (e.g. access to ducts, *"*unbundling*"* of the copper sub-loop or of the fibre loop) as the most fitting way of promoting competition where economically feasible, recognizing that, in practice, the result should be a combination of active and passive access products.

In October 2010, Ofcom (2010a) launched a public consultation *"The Wholesale Broadband Access"*, which closed in July 2010, proposing to promote greater competition in current broadband. As such it defines four different geographic markets:

a) The Hull area (covering 0.7% of households in the United Kingdom): areas covered by exchanges where KCOM is the sole operator;

b) Market 1 (covering 16.4% of households in the United Kingdom): the areas covered by exchanges where BT is the sole operator;

c) Market 2 (covering 13.7% of households in the United Kingdom): the areas covered by exchanges where there are two or three operators;

[282] http://www.ofcom.org.uk/consult/condocs/wbamr07/statement/.

d) Market 3 (covering 69.2% of households in the United Kingdom): areas covered by exchanges where there are four or more operators;

Accordingly, this consultation proposes the following remedies:

a) In Market 1, there is limited perspective in the short term of any competition in the wholesale offer. Therefore, Ofcom proposes to impose general access and non-discrimination obligations on BT. It also proposes to order that prices be based on costs and impose a cost accounting obligation to ensure transparency of information about costs;

b) In Market 2, while BT has SMP, there is some wholesale competition and potential for this to develop further. It is deemed appropriate to impose general access and non-discrimination obligations on BT to address its position of SMP and the concern that BT could raise prices to an excessive level. There is some wholesale competition in market 2 and a potential for this to continue to develop. Ofcom considers that strict price regulation is not adequate to achieve this objective. Instead, it suggests a degree of freedom of pricing within a range, based on a general obligation of cost orientation. It also proposes a cost accounting obligation to ensure transparency;

c) In the area of Hull it proposes to impose general access and non-discrimination obligations on KCOM. It does not propose to impose any regulation of prices.

After the launch of the public consultation, Orange entered into an agreement with BT for the supply of wholesale broadband access services, reducing the number of operators in the market from seven to six.[283] Since this change has implications for the definition of WBA markets, which are used to determine whether BT has significant market power (SMP), as well as the basis for the way BT established wholesale broadband access, in August, OFCOM (2010b) decided to consult the market again, and so launched a new "Wholesale Broadband Access" public consultation.

In the new document, the following modifications to the definition of geographic markets are presented:

a) The Hull area (covering 0.7% of households in the United Kingdom): areas covered by exchanges where KCOM is the sole operator;

[283] BT, C&W, O2, Sky, TalkTalk and Virgin Media.

b) Market 1 (covering 11.7%[284] of households in the United Kingdom): the areas covered by exchanges where BT is the only operator;

c) Market 2 (covering 10.0%[285] of households in the United Kingdom): areas covered by exchanges where there are two or three operators or where BT's share exceeds 50%;

d) Market 3 (covering 77.6%[286] of households in the UK): areas covered by exchanges where there are four or more operators or where BT's share is less than 50%.

At the same time, also in March 2010, Ofcom (2010c) launched a public consultation on the obligations applicable to operators with SMP on the ″wholesale local access market″, a market which includes the services provided over fixed physical infrastructure that connects the customer premises to the local exchange (including copper loops, coaxial cable and fibre but not including mobile, fixed wireless and satellite technologies).

In February 2008, Openreach began a test deployment of fibre access on the ground in Ebbsfleet Valley, Kent (where GPON FTTH is being deployed to 10 thousand homes) and from August 2008, has provided fibre-based broadband at speeds of 100 Mbps to residential customers (an "equivalent" wholesale product will also be offered).

Meanwhile, in February 2008, Ofcom launched a public consultation on the need to create a new numbering range to cover the Ebbsfleet Valley area. In the last quarter of 2008, BT began implementation of the *"super-fast broadband"* (up to 100 Mbps) plan, whereas an investment was envisaged, *id temporis*, totalling 1.7 billion euros[287] by 2012, when ten million homes should be covered.

It should also be taken into account - given that the private sector, according to an independent report prepared for the government (Caio Report) will not suffice to guarantee universal NGN access throughout the country - that the Government's role in NGN development, including in particular the possible extension of universal service to broadband, is being addressed in the *"Digital Britain"* project.

It is also within the scope of the project - and as established in the Digital Economy Act, given assent in 2010 – that the goal was established to ensure universal access to broadband throughout the country (including in rural regions) - in this case only at rates of up

[284] 14.2% in the March version
[285] 13.8% in the March version
[286] 71.3% in the March version.
[287] £1.5 billion (exchange rate on 10.02.2010).

to 2 Mbps, with public funds totalling 228 million euros.[288] This objective, which initially had a target of 2012, was recently revised by the Government, and it is now estimated that it can be achieved by 2015. With regard to access to NGA, it is assumed it will possible to achieve coverage of 90% of homes by 2017.

In terms of regional and municipal governments, especially in rural areas, note is made of the Digital Region project, whose implementation began in June 2009 and which is expected to be concluded within three years. The investment associated with this project, partly funded by the EU, is estimated at 128 million euros and it should offer speeds of between 25 Mbps and 50 Mbps to about 550 thousand homes and 40 thousand companies in South Yorkshire.

Note should also be made of the initiative that seeks to promote the deployment of NGA in North Yorkshire. This initiative stems from the fact that a project (co-financed by the EC) initiated in 2007, which led to the deployment of backhaul in fibre interconnecting twelve points of presence in rural North Yorkshire, was already deemed insufficient to meet the current needs of users. Accordingly, the present goal is to create additional points of presence in North Yorkshire[289] enabling service of "white areas" lacking adequate broadband infrastructure, with downstream speeds to the order of 10 Mbps, 100 Mbps and 1 Gbps.

The North Yorkshire initiative will be co-financed by EAFRD and the British government, and the project's compliance with EU legislation was validated in June 2010.

There are other examples of projects which seek to articulate the development of regional initiatives, such as the Independent Networks Cooperative Association, the Community Broadband Network and COTS project (Commercial, Operational and Technical Standards).

Meanwhile, in the consultation document published by Ofcom on 31.07.2009 (Next Generation Networks - Responding to recent developments to protect consumers, promote effective competition and secure efficient investment)[290], is it noted that, in light of the current economic situation, service providers are redefining their investment priorities. In this process, they are focusing on the following:

a) Cost savings arising from NGN only become apparent after a period when costs increase;

[288] £200 million (exchange rate on 10.02.2010).

[289] With exception of the cities of cities of Harrogate and York, where Virgin and BT already offer services supported on NGA.

[290] http://www.ofcom.org.uk/consult/condocs/ngndevelopments/main.pdf.

b) The benefits associated with launching new products emerge only after real market opportunities are identified, whereby, in the short term, there is a risk that NGN represents higher costs but no new revenue sources.

It can therefore be expected that the pace of NGN deployment by BT will be slower than initially envisaged and that traditional parts of the network will be replaced only when they reach the end of their useful life, with investments made only where demand is certain.

Taking this development into account and the premise that competition in terms of NGN supported services will increase rapidly (as occurred with the Internet), Ofcom questioned to what extent regulatory intervention in the context of NGN is really necessary.

Accordingly, on 01.10.2009, Openreach[291] announced the development of an FTTP pilot project in "brownfield sites", to be developed from January 2010. This project incorporated FTTC and FTTP technologies, with FTTC predominating, whereas Openreach envisages wholesale access to this network by interested service providers. The initial downstream capacity was 40 Mbps and may exceed 60 Mbps in the future.

Two areas were selected for the project (Bradwell Abbey in the town of Milton Keynes and Highams Park in London), each one with about 20 thousand households and businesses.

The goal of this pilot-project was to enable Openreach to conclude on the performance of the technology and costs associated with FTTP in areas the copper network services are available.

Currently, Openreach is offering FTTP services in a new urban development in Ebbsfleet Valley (Kent), whereby users located in this area will benefit from speeds of up to 100 Mbps.[292]

Basically, BT's strategy now appears to involve a reduction in investment in FTTC and increased investment in FTTB/FTTH.

As far as BT's competitors are concerned, the most active seems to be Virgin Media, which offers broadband services supported on cable (DOCSIS 3.0) with speeds of up to 50 Mbps to about half of its customers, aiming to increase speeds offered to these customers to 100 Mbps by mid-2012. Virgin's offer basically focuses on major cities and metropolitan areas.

[291] Openreach is a division of BT Group, created following an agreement with OFCOM (to implement determined aspects of the *Enterprise Act 2002*) with the goal of ensuring that all competitors have equal access to BT's network (see http://www.openreach.co.uk/orpg/products/nga/sfa.do).

[292] http://www.eurocomms.com/online_press/113270/Openreach_to_trial_fibre-to-the-premise_in_brownfield_sites.html.

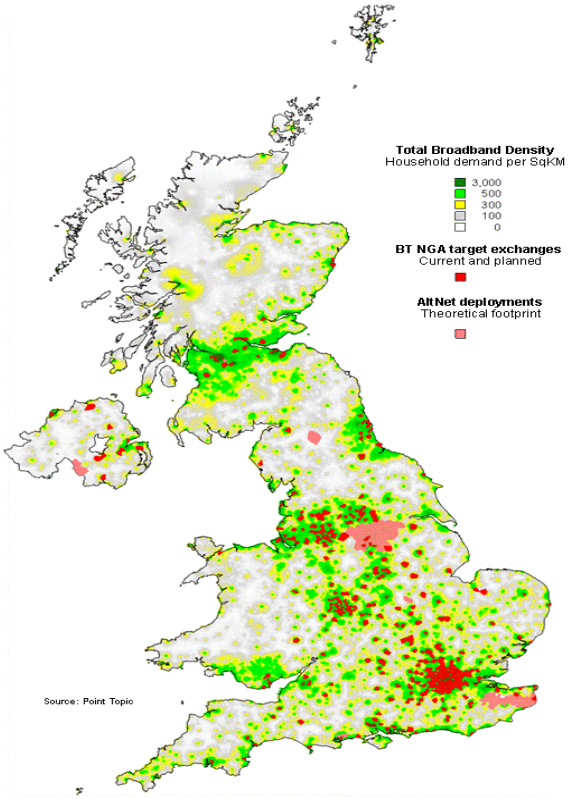
Since May 2009, tests have been conducted in Ashford (Kent) with speeds of around 200 Mbps. Virgin's estimated investment is to the order of 222 to 334 million euros.

Other initiatives have been undertaken by small scale operators in areas such as London (especially Velocity1 in the Wembley area, where in June 2009, it had connected two hundred eighty-six residences and fifteen non-residential units), Bournemouth, Glasgow and towns in Northern Ireland and in Rutland.

The map shown in Figure 55 gives an overview of areas in the United Kingdom where NGA is already deployed or where deployment is due to occur, as well as expected potential demand.

The areas in red correspond to BT, with the pink areas showing sites of planned coverage by alternative operators.[293] The contribution of alternative operators is limited[294], and some of them have still have only a vague definition in relation to the issues of coverage and services to be offered.

Figure 55 Network of existing and planned NGA in the United Kingdom



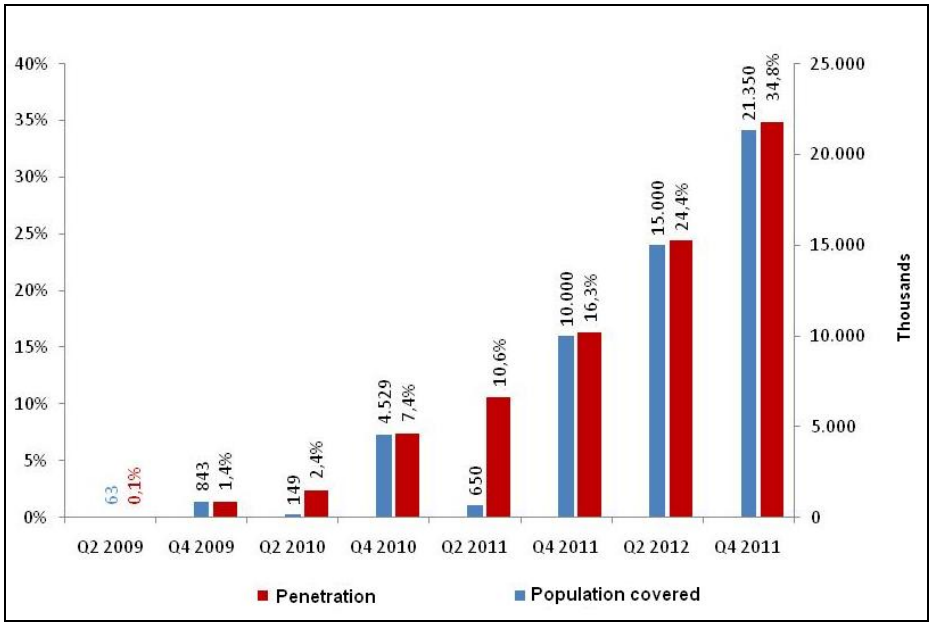
Source: Point Topic (2009)

[293] Data published by *Point topic* in 2009. See http://point-topic.com/content/ukplus/shortreports/BBV187ngamap091111.htm.

[294] On this map, only projects which already have approved funding are considered.

Point Topic predicts that the population covered by the development of NGA by BT will reach 34% of the total UK population by the end of 2012 (see Figure 56).

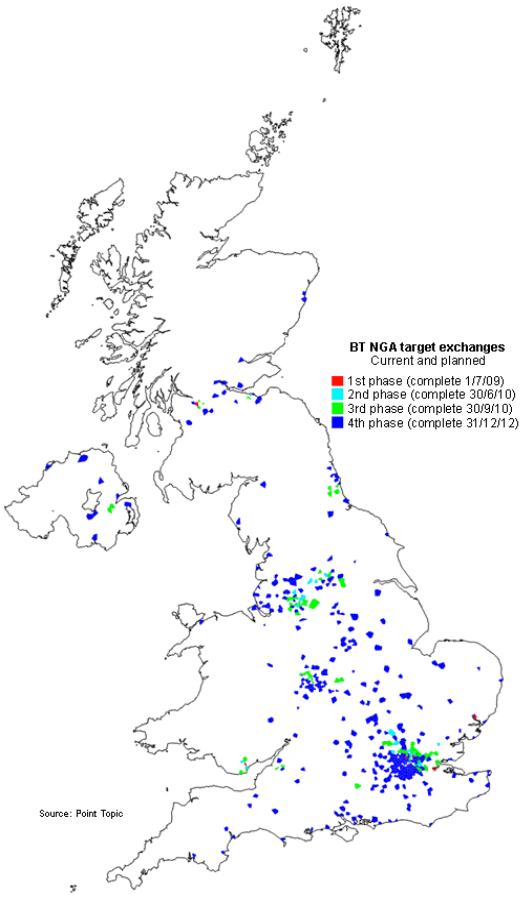
Figure 56 Evolution of the coverage of broadband of the United Kingdom



Source: ICP-ANACOM, based on data from Point Topic (2009)

Developments in BT's plan on the ground, in terms of areas to be covered, is shown in Figure 57, where, as already mentioned, it is expected 60% of the United Kingdom's population will not have access to NGA before 2012.

Figure 57 Development of NGA in the United Kingdom by BT



Source: Point Topic (2009)

In the United Kingdom, the estimated potential demand for services based on NGA[295] suggests that only areas with over 500 lines per km^2 may be economically viable without subsidies and that in areas with over 100 lines per km^2, NGA may be made feasible with a moderate level of subsidies. In areas with fewer than 100 lines per km^2, a viable business of NGA services will tend to require higher levels of subsidies, coupled with creative solutions.

On 21.12.2009, BT announced its intention to complete the development of its ultrafast broadband network in time for the 2012 London Olympics, covering 40% of households in the country, envisaging, *id temporis,* four million homes with access by fibre at the end of 2010.

However, according to data from Point Topic[296], released on 08.02.2010, there were 3 thousand optical fibre accesses installed in the United Kingdom at the end of 2009, comprising 1.7 thousand alternative operator customers and 1.2 thousand BT customers

[295] Expressed as a ratio between potential demand for broadband lines in an area and the size of the area in square kilometres.

[296] http://point-topic.com/content/dslanalysis/bbanga1002.html.

(the vast majority with FTTC architecture[297] and a small number in FTTP).[298] According to data from Cullen International, in late 2010, BT will have about 20 thousand homes passed with GPON FTTH and 500 thousand homes passed with FTTC+VDSL2, while Virgin will have about 12.7 million homes passed with DOCSIS 3.0.

At the end of 2010, BT concluded the "Race to infinity" contest, in which citizens could vote *"*on line*",* expressing their intention to take up future services supported over an NGA network with a downstream capacity of 40 Mbps. As a result, six communities were selected to benefit from this type of access by 2012, namely, Baschurch (Shropshire) Blewbury (Oxfordshire), Caxton (Cambridgeshire), Innerleithen (Scottish Borders) Madingley (Cambridgeshire) and Witchurch (Hampshire).

Meanwhile Openreach brought forward the completion date of its investment plan[299] to June 2012, nine months earlier than originally planned. Setting out the installation of 4,500 street cabinets by March 2010, to serve one million homes. In March 2011, 20 thousand installed cabinets are expected. According to BT, the dominant architecture for the development of fibre will be FTTC, although there may be places where FTTC will coexist with FTTP.

In March 2010, BT demanded that Ofcom require Virgin Media - currently offering access speeds of 50 Mbps and preparing to launch an offer of 100 Mbps (DOCSIS cable modem) by the end of the year - to open their underground ducts for use by other operators. So far there has been no reaction from the regulator. At the end of 2009 Virgin Media, had approximately 42 thousand users[300] with offers of 50 Mbps (with a growth rate of 81% in the previous quarter); whereas it continues to upgrade of its network, so that it will be able to reach 12.5 million homes with an offer of 50 Mbps.

On 02.06.2010, the EC announced its acceptance of the United Kingdom regulator's proposal to oblige BT to supply VULA access.[301] It was the first time that an NRA from the EU proposed a practical solution to ensure access to "point to multi-point" fibre infrastructure.

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[297] In the areas of Muswell Hill and Whitchurch.

[298] In the area of Ebbsfleet.

[299] With a planned value of £1.5 billion, equivalent to 1.7 billion euros (exchange rate on 10.02.2010).

[300] Data from Ovum.

[301] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/654&format=HTML&aged=0&language=EN&guiLanguage=en.

According to Ofcom, VULA should allow access to the NGA network in a manner similar to an advanced bitstream offer (access to Ethernet). Rather than providing a physical line (as in LLU), VULA provides a virtual connection based on Ethernet, giving the OSP substantial control over traffic and service levels, particularly in the constitution of the data frame and control of customer-located equipment. Access through VULA incorporates two virtual access solutions, both for FTTC architecture and for FTTH (FTTP, according to Ofcom terminology).

The essential features of VULA are:

a) Interconnection should occur locally, i.e. at the first technically feasible point of aggregation. In practice, the first Ethernet switch on the customer side;
b) Agnostic in terms of service, i.e., it should be able to support a large variety of services in a neutral manner;
c) Without contention, i.e., the connection between the end-user and the point where the interconnection of the OAO to the wholesale operator, should be dedicated to the end-user;
d) Control of access should be available. Alternative operators need more freedom in controlling access in order to supply different types of services and, potentially, to vary the QoS parameters in their services, enabling them to compete with other operators;
e) Control of terminal equipment at the customer premises (*Customer Premises Equipment* (CPE)) must be available.

The EC considered that VULA will allow differentiation and innovation in terms of supply of wholesale products similar to the physical unbundling of the local loop (also taking into account the functional separation of BT), recognizing that it is the best option under present market conditions of NGA in the United Kingdom, to ensure competition and allow end-users to benefit from a wide range of services provided through an optical fibre infrastructure.

Despite these aspects, the EC drew attention to the fact that this solution does not allow alternative operators the same freedom in supplying retail products, compared to that obtained through the full unbundling of the fibre local loop, emphasizing that, in principle, NRA should make unbundling of the fibre local loop mandatory, regardless of the dominant operator's network architecture. Accordingly, it considered VULA as a transitional measure, whereby this remedy should be replaced as soon as possible, and as soon as necessary technical and economic conditions allow, with unbundling of the fibre loop.

With respect to the prices to be charged for VULA, the EC deemed that, contrary to Ofcom's proposal, these must be cost oriented. According to the EU regulatory framework, the proposed prices have to be adjusted to take into account the investment risk in the established contractual context, thereby promoting competition and investment in NGA.

Also in relation to NGA access, particularly with regard to the interface/interconnection between the wholesale operator and retail operators, Ofcom considered that the document of March 2009, in which it expressed its view on what it considers should be *Ethernet Active Line Access* (ALA) and which corresponds to an outline of the minimum technical requirements of the interface, is a useful reference when considering the characteristics of VULA.

ALA is an attempt by Ofcom to standardize the interface/interconnection between OAO and wholesalers, and for such it proposed a well-defined technology for this interconnection which can function on any NGA infrastructure. The proposal focused on Ethernet technology, one which it considers is well known and well defined, and which is economic and ubiquitous with a high level of interoperability. Therefore, and in order to standardise the interface for a bitstream offer, Ofcom Identified five functional characteristics of the Ethernet ALA, including:

a) Capacity to provide security;
b) Capacity to provide quality of service;
c) Capacity to provide *multicas*t;[302]
d) Flexible with regard to customer terminal equipment;
e) Flexible with regard to interconnection and aggregation.

Openreach currently provides a wholesale offer for FTTC and FTTP similar to VULA which this operator calls Generic Ethernet Access FTTC **(**GEA-FTTC) and Generic Ethernet Access Fibre to the Premises (GEA-FTTP). According to Ofcom's analysis of VULA, although GEA, including GEA-FTTC, is practically compatible, it will have to evolve in terms of enabling greater control of terminal equipment by alternative operators, which should have freedom of choice when it comes to such equipment in order to have greater flexibility.

[302] *Multicast* is the simultaneous delivery of information to multiple destinations using the most efficient strategy where messages will only go through a link once and are only duplicated when the link to the recipients is divided into two directions. In comparison with the *Multicast*, simple point-to-point delivery is called *Unicast*, and delivery to all points of a network is called *Broadcast*.

GEA must also evolve in order to provide a greater degree of interconnection control to alternative operators so that they can provide all services and potentially different levels of quality of service in the services delivered.

GEA will be available to all communications providers in the United Kingdom for FTTP and FTTC, based on bitstream and supported using Ethernet technology, since, according to Openreach, this technology is very competitive in terms of equipment, offers a ubiquitous service interface, gives operators the ability to innovate with respect to IP services, provides flexible bandwidth with small increments and enables support for multiple operators on the same physical interface. In this solution, there is total IP and Ethernet transparency between the end-user and the operator's OLT "gate". Openreach is responsible for the network itself while the operators are responsible for the connection of their network to Openreach's network and for supplying end-equipment to their customers.

Beyond the provision of VULA, Ofcom proposes to apply a number of obligations, key among which are maintenance of LLU and SLU and access to ducts and masts. Ofcom also proposed that these latter three services should be provided at prices based on long-run incremental costs, including an appropriate share of common costs. With regard to VULA, the regulator has not proposed price control based on LRIC, since this service will not, *ab initio,* see stabilisation and also because BT would have no incentive to charge an excessive price (it is claimed because it would seek to capture traffic for its NGA).

The case of the United Kingdom (as already mentioned in the case of Australia) shows that the approach of vertical functional separation, followed to encourage the NGN deployment, while contributing to the guarantee of non-discrimination in wholesale electronic communications services, may not yet have provided the best results in terms of NGA development. While the United Kingdom has devoted a lot of time and resources to discussing the best strategies and solutions in terms of public policy and regulatory frameworks to promote the deployment of broadband and in particular of NGA, the case of Portugal demonstrates that a speedy resolution of public policies and of regulatory solutions, combined with competitive conditions, has undeniable advantages.

4.13 Singapore

The city-state of Singapore is characterized by a high broadband penetration rate (183.5% penetration rate in households, according to data referring to the third quarter of 2010 from the IDA - Infocomm Development Authority of Singapore)[303], driven by a high degree of

[303] http://www.ida.gov.sg/Publications/20100908153408.aspx.

verticality and population concentration. Mobile broadband is by far the most used technology, followed by cable and DSL.

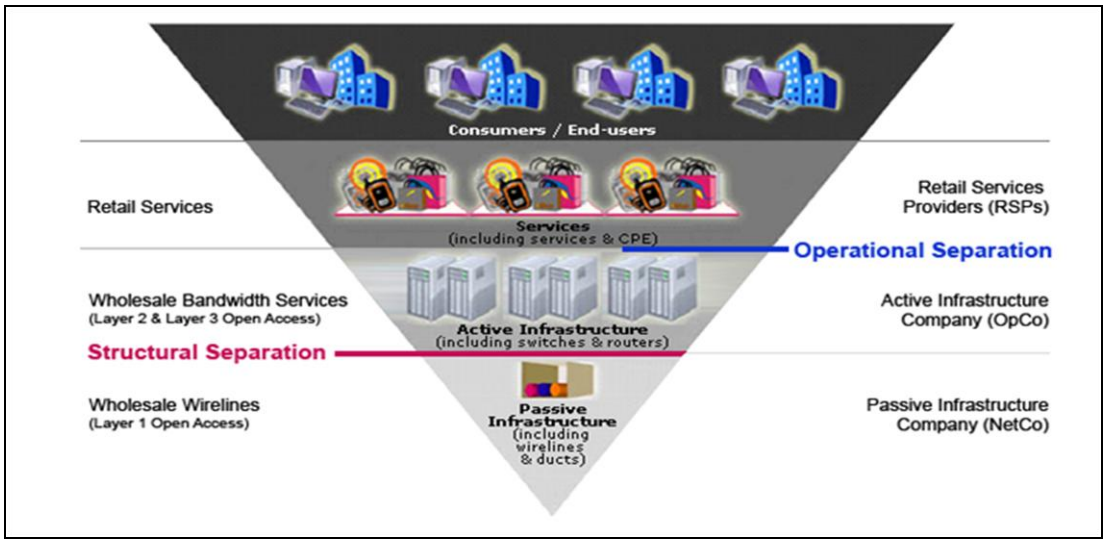
An advanced vision for the country is projected for 2015 ("*Intelligent Nation 2015*") in terms of broadband at affordable prices, and in terms of information highways and network computing, in order to drive the development of activities in areas such as banking, finance, digital media, health care and life sciences.

In this context, the State decided to implement a Next Generation National Broadband Network ("*Next Gen NBN*"), capable of offering speeds of around 1 Gbps, structured in three layers (see Figure 58), namely: (a) an network company ("NetCo"); (b) an operating company ("OpCo") and various providers of retail services ("RSPs"), which ensures operational and structural separation.

NetCo is responsible for establishing the passive infrastructure, whereas OpCo is responsible for operating the network's active components and supplying bandwidth to providers, who are responsible for providing retail services to end-users.

The IDA has chosen, after consideration of proposals submitted, OpenNet (in September 2008) and Nucleus Connect[304] (in April 2009) as NetCo and OpCo respectively.

Figure 58 Layers of the Next Gen NBN



Source: IDA

OpenNet is a consortium established in 2008 between Axia NetMedia, Singapore Telecommunications (SingTel), Singapore Press Holdings and SP Telecommunications, which selected Alcatel-Lucent to integrate their operations and business support systems

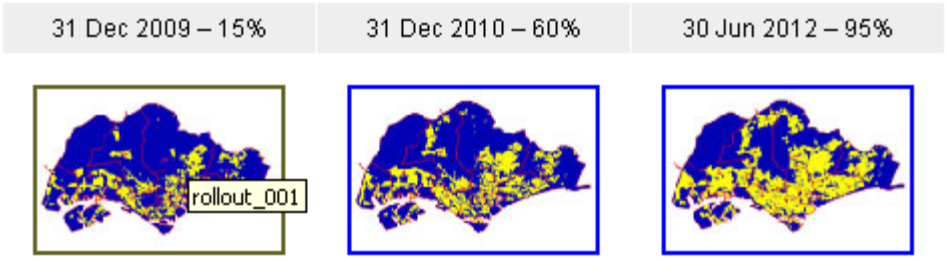
[304] http://www.nucleusconnect.com/services-NetOverview.php and http://www.nucleusconnect.com/services-SerOverview.php

(this equipment manufacturer should ensure a system architecture compatible with the principles of open network and equivalence of inputs).

It is noted that Alcatel-Lucent (together with Huawei) was also selected by Nucleus Connect as a supplier of equipment and systems integrator.

OpenNet's coverage targets are shown in **Figure 59**, supported for this purpose by a government grant of around 383 million euros.[305]

Figure 59 OpenNet Coverage Objectives



Source: IDA

From 2012, NetCo plans to respond to all requests for additional installation and both this company and OpenNet will be subject to universal service obligations.

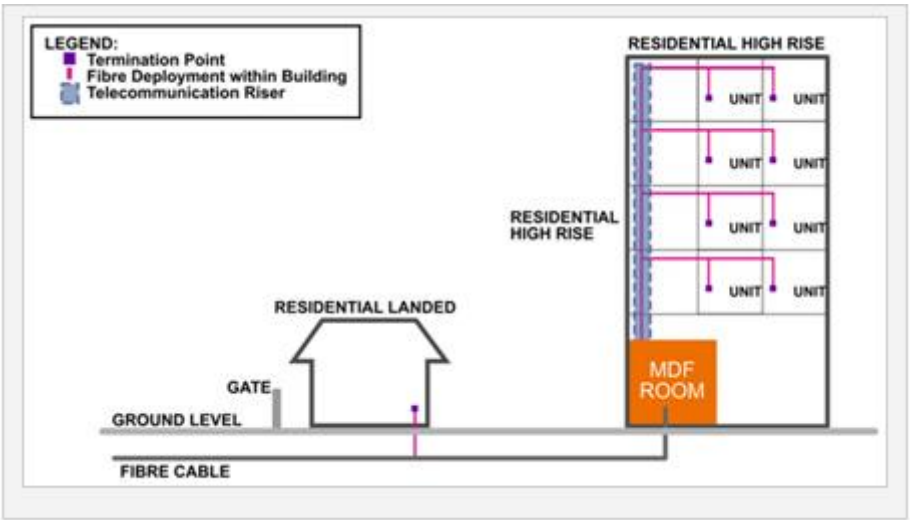
In August 2009, there were already 32 thousand homes passed and 500 passed non-residential units. According to Ovum estimates, in 2012, there will be about 390 thousand FTTH customers, representing a penetration rate of approximately 35% of households.

Each resident must pay the corresponding prices of fibre installation. For an initial period, installation is free, unless the fibre length exceeds fifteen meters from the house entrance (in which case 195 euros will be payable[306] for each additional five meters). After the initial period, 160 euros will be payable per installation[307] (in case of tall buildings) or 328 euros[308] (in other buildings), in addition to the price cited in cases where the fibre length exceeds fifteen metres.

As far as residential buildings are concerned, OpenNet will bring the fibre up to the building's first termination point (see Figure 60).

[305] 525 million U.S. dollars (exchange rate on 10.02.2010).
[306] 233 U.S. dollars (exchange rate on 09.06.2010)
[307] 220 U.S. dollars (exchange rate of 10.02.2010).
[308] 450 U.S. dollars (exchange rate on 10.02.2010).

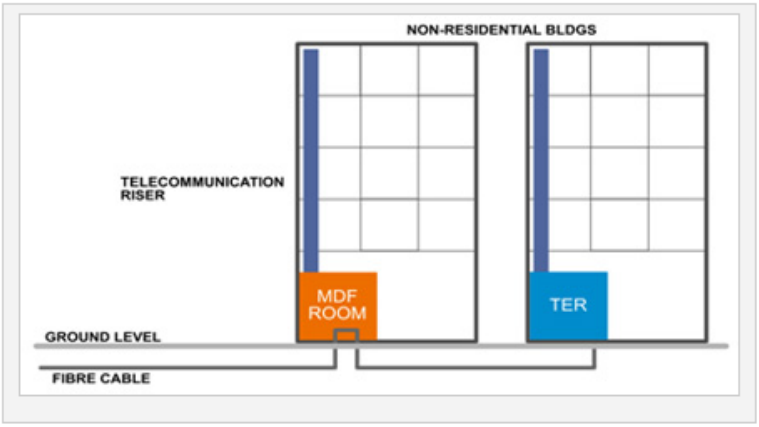
Figure 60 OpenNet Fibre - residential buildings



Source: OpenNet

In the case of non-residential buildings, OpenNet will bring the fibre to the building's MDF or electronic communications equipment room (see Figure 61).

Figure 61 OpenNet Fibre - non-residential buildings



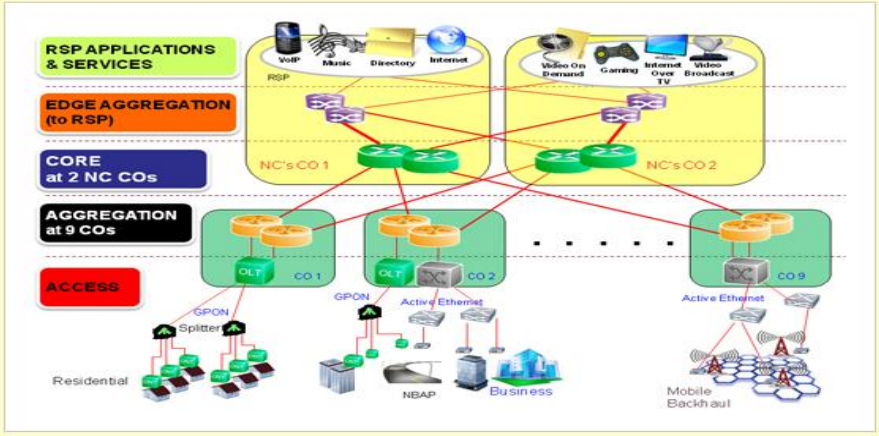
Source: OpenNet

The wholesale services provided by OpenNet to its client companies consist in the most part of the non-discriminatory provision of dark fibre and co-location facilities.

Two options are available in terms of speed: Residential customers can choose 100 Mbps of downlink and 50 Mbps of uplink or 1 Gbps of downlink and 500 Mbps of uplink, while non-residential customers may choose symmetrical bandwidth of 1 Gbps or 100 Mbps.

The network architecture (see Figure 62) can be characterized as GPON (for multi-point access for residential and non-residential customers), using Ethernet technology for active access (especially in providing symmetrical bandwidth to residential customers in high buildings) and MPLS IP Core.

Figure 62 Architecture of network deployment in Singapore



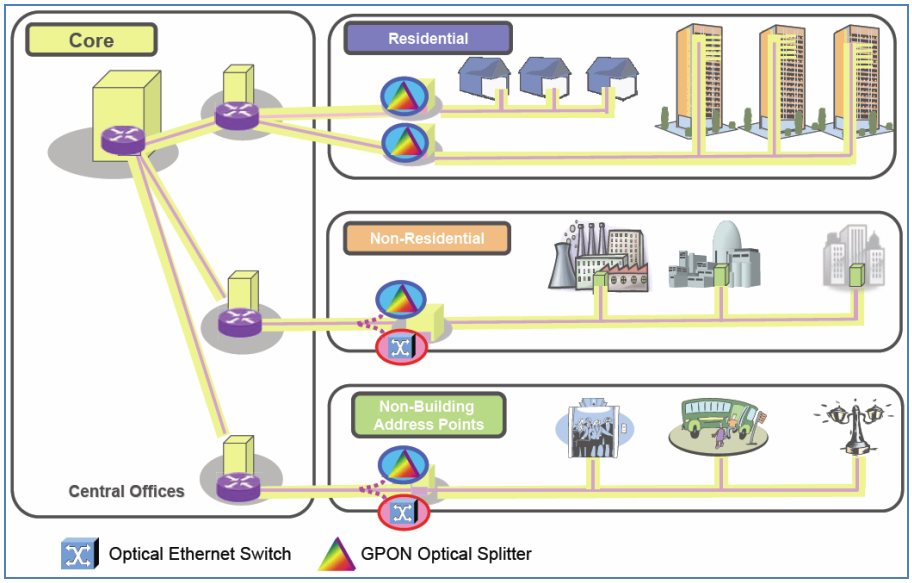
Source: Nucleus

In the case of the GPON network, at core network level (see Figure 63) the information (packets) from the various retail operators are encapsulated and sent to each splitter, connecting each of the end-customers to the network.

Information in the downstream direction is transmitted in broadcast mode, whereby all information is transmitted to all network elements and only accepted by the corresponding terminal.

In the return channel (upstream direction) transmission is performed using TDMA multiple access protocol, where each network element has a specific time period for transmission, allowing a single transmission channel, in this case the same wavelength, to be shared by multiple customers. For the connection of residential customers, the topology used is Ethernet-based with each customer connected to a fibre not shared with other customers. In this type of network, information at access network is not sent in broadcast mode, instead it is directed at each of its intended customers. This process is achieved through Internet Protocol (IP). At Core network level, the process is identical to that of GPON connection.

Figure 63: Implementation of OpenNet Network



Source: IDA

According to Pyramid Research (2010), the development of a national fibre network will drive growth in the adoption of VoIP and IPTV, with growth of 20.4% expected for VoIP and 41.1% for IPTV over the next five years. Subscription television has a penetration rate approaching 65%, with forecasts pointing to a growth rate of up to 89% over the same five years.

The models of economic and social development, the size of the territory and the verticality of construction in Singapore and Portugal are very different. The type of industrial policy based on the government's promotion of structural separation into three "layers" is also a peculiarity of the city-state. Nevertheless, it is possible to note that both in the Portuguese case as in the case of Singapore, there is an evident basic concern with achieving efficient and non-discriminatory access to network infrastructure, driving appropriate levels of retail competition and the development of next generation networks and services.

4.14 Sweden

In April 2007, PTS (NRA) of Sweden published the document *"Proposal for Swedish Broadband Strategy"*, with a view to defining a strategy that will lead to all homes, businesses and public entities being connected to broadband by 2010. In June 2007, the same organization published the document "Improved broadband competition through functional separation", in which it advocates the advantage of the functional separation of the historic operator (TeliaSonera) for the development and promotion of competition in broadband.

The strategy set out by PTS for broadband development focuses on three areas: (a) targets and measures in terms of accessibility; (b) the need for a model which enables equal treatment among operators; and (c) open networks, with special focus on operator access to local optical fibre networks.

The NRA acknowledged that there are "important public interests that cannot only be met through the private market and through the promotion of competition" such as the availability of a modern and robust network throughout the national territory with a high level of transmission capacity. Therefore, it suggested to the government that it formulate a long-term goal for broadband infrastructure access (embodied in a set of measures given a budget of 109 million euros[309], of which about half would come from structural funds and rural development programmes). It also suggested that efforts be made to include broadband in the concept of universal service, as part of the review of the Universal Service Directive.

It was in this context that the Swedish government set coverage targets, for 2015 and 2020 respectively, of 40% and 90% of residential and non-residential customers with downstream speeds of 100 Mbps, and with the goal that everyone will be able to access broadband services with downstream capacity of 1 Mbps as early as 2011.

Achieving these goals will involve an increase in broadband coverage in rural areas, covering 25 thousand properties (of which about 4/5 will be residential and 1/5 business).

Total public investment associated with the accomplishment of the targets mentioned above, over the period 2010-2013, should be around 28.2 million euros, of which ¾ will be supported by EAFRD and ¼ by the Swedish government, whereas the EC concluded in March 2010 that this project was compatible with the requirements of Community law.

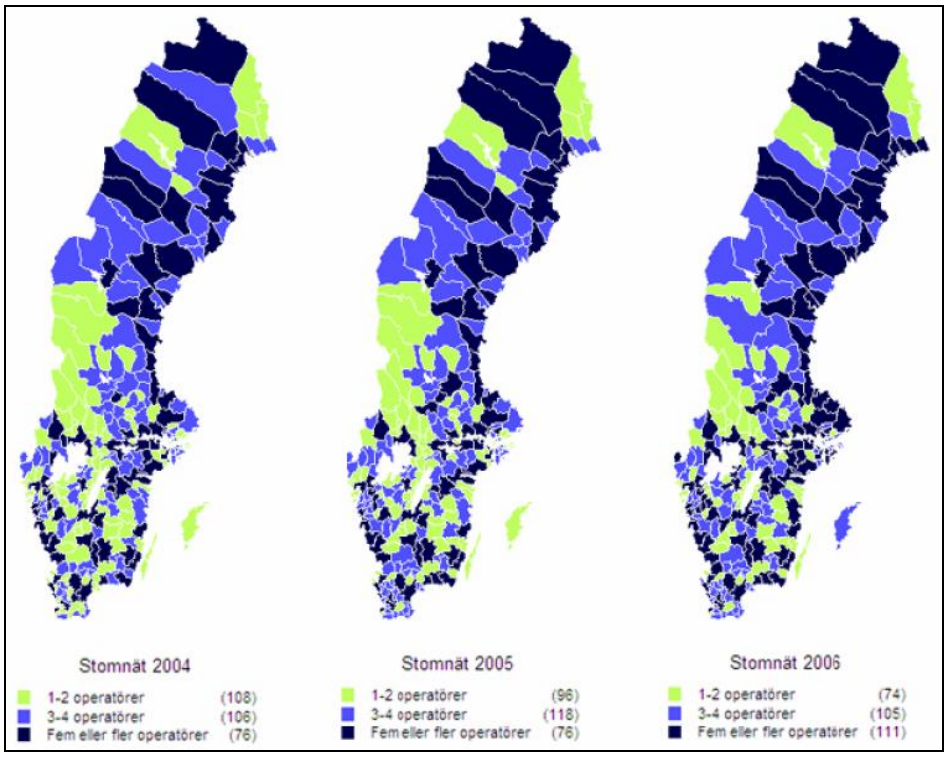
To help the government in implementing its objectives, a Broadband Committee was set up, involving the NRA, operators, public bodies and other organizations.

It is noted that the regulator's concerns regarding the deployment of fibre networks focuses only on the access network, since a growing plurality has been seen in optical fibre transmission networks. Figure 64 shows the evolution of optical fibre transmission networks between 2004 and 2006, showing areas with networks of one or two operators, three to four operators and five or more operators.

[309] About 1.135 billion Swedish Koruna (exchange rate on 22.12.2009).

PTS (in line with the United Kingdom's *Openreach* approach) argued that the appropriate model for ensuring equal treatment should be based on the functional separation of TeliaSonera and, meanwhile, announced that the conditions of migration to NGN and the phasing of the existing infrastructure would be subject to future examination.

Figure 64: Evolution of optical fibre transmission networks in Sweden.



Source: PTS (Improved broadband competition through functional separation)

Given that the Swedish regulatory framework offers only very limited scope for any regulatory imposition of functional separation (even following market analysis reviews) and considering that the State is the main shareholder (about 37% of capital) of TeliaSonera (Sweden historic operator), the NRA has recommended to the government that it take steps with a view to TeliaSonera undertaking functional separation on a voluntary basis and that it amend legislation to enable the regulator to accept voluntary commitments by operators.

For PTS, functional separation is capable of reducing the risk of future monopoly in the access network, given the assumed approximation of the access point in relation to buildings in migration to NGA. Meanwhile, the NRA considers that functional separation would not reduce incentives to invest in NGA, since it would remove barriers to investment (relating, for example, to rights of way) and would result in greater transparency for investors, and also increase efficiency in the use of passive infrastructure.

As such, on 17.01.2008, the government decided to advance with the acceptance of both of the regulator's proposals[310], even while the historic operator considers that functional separation would undermine its willingness to invest.

One of autonomous units resulting from the functional separation sought by the regulator would cover, at a minimum, LLU and associated services, including, in particular, resources allowing the deployment of FTTC. Another self-contained unit will include bitstream and associated services.

In this context, on 01.01.2008, TeliaSonera set up TeliaSonera Skanova Access AB, a new subsidiary owning the wholesale network infrastructure, in order to respond to concerns about transparency and control. The new company employs approximately seven hundred people and has an estimated value of annual net sales totalling around 674 million euros.[311]

On 15.12.2009, TeliaSonera[312] announced the deployment of a 4G service, in partnership with mobile operator Ericsson to offer commercial services in Stockholm, aiming to bring this service to over twenty cities in Sweden by the end of 2010. Up to the end of June, the promotional monthly charge, including 30 GB of traffic per month, was 0.4 euros, with the current value at 60 euros. Meanwhile, in December 2009, it launched the first commercial service based on an LTE network in Oslo, Norway, in partnership with Huawei.

Sweden's NRA also sought the allocation of powers to order that broadband networks financed by public funds be open to other service providers.

PTS also recommended that the government take into account the following guidelines when assigning funds:

a) Proceed with payment for broadband infrastructure deployment in areas where such infrastructure does not exist (especially in rural areas and small communities);
b) Provide support in a manner that is technologically neutral;
c) Guarantee that infrastructure financed by the government is open to all service providers, especially given that "it will rarely be commercially feasible or socio-economically desirable to install parallel fibre networks at an access line level".

Another measure recommended by PTS is that joint planning of ducts (currently followed by municipalities in respect of electronic communications, heating and road paving works) - which results in significant cost savings - be extended to energy distribution companies.

[310] http://www.sweden.gov.se/sb/d/586/a/96173.

[311] About 7 billion Swedish Koruna (exchange rate on 22.12.2009).

[312] See http://www.telecomengine.com/NewsGlobe/article.asp?HH_ID=AR_6013.

In 2010, with the aim of deploying broadband networks in rural areas[313], PTS has received about 10.6 million euros[314] of the Swedish government to stimulate the expansion of broadband in these areas. This public fund may be used by local associations, other local development groups and by municipalities to develop projects in order to access other support of 27.9 million euros[315], established as part of the *Rural Area Programme*[316]. However, part of the support requires the involvement of customers in supporting a part of the costs. Certain municipalities perceive this as a problem that will make the deployment of broadband projects in rural areas difficult.

At the level of the spectrum, on 28.09.2009, PTS launched a public consultation[317] on the future use of the 800 MHz band (currently used by terrestrial broadcasting), which may increase opportunities for end-users in gaining access to wireless broadband services[318] (in Sweden, about 144 thousand residential households and businesses premises have conditions which only permit access to wireless broadband).[319]

Following the public consultation, on 13.12.2010, PTS published a document[320], setting out the conditions of the auction that will start on 28.02.2011, with the aim of inviting all market *players* to participate in the auction[321] of 800 MHz. In total, 2x30 MHz of spectrum will be auctioned, corresponding to a total of six licenses, 2x5 MHz each, with each operator able to win a maximum of 2×10 MHz of total available spectrum. An interesting component of the auction is the inclusion of a social agenda for achieving the general objectives of the Swedish government's broadband programme ("Broadband Strategy for Sweden")[322], whereby in one of the licenses, PTS imposes a stipulation in terms of coverage, requiring the

[313] It is noted that around 12% of the Swedish population lives in rural areas.

[314] 95 million Swedish Koruna (exchange rate on 24.01.2011).

[315] 250 million Swedish koruna (exchange rate of 24.01.2011).

[316] http://www.jordbruksverket.se/bredband.

[317] http://www.pts.se/en-gb/News/Radio/2009/PTS-requests-views-on-the-assignment-of-the-800-MHz-band/.

[318] http://www.pts.se/en-gb/News/Press-releases/2007/Public%20consultation%20of%20PTS%20draft%20auction%20rules%20for%20future%20wireless%20broadband/.

[319] http://www.pts.se/en-gb/Documents/Reports/internet/2008/Broadband-survey-2007---PTS-ER-20085/.

[320] Open invitation to apply for a licence to use radio transmitters in the 800 MHz band, http://www.pts.se/upload/Beslut/Radio/2010/10-10534-open-invitation-800-mhz-auction-dec10.pdf.

[321] SMRA Auction (*simultaneous multiple round ascending*) with "augmented switching": The rules are designed to promote the realisation of the real value of the spectrum, seeking to discourage artificial strategic behaviour, such as bidders driving disproportionate increases in the prices of certain lots or hiding their true ambitions until the end of the auction.

[322] http://www.sweden.gov.se/download/112394be.pdf?major=1&minor=134980&cn=attachmentPublDuplicator_0_attachment.

winning bidder of this license to provide the service so that all houses and businesses which are currently without broadband service are covered by the new broadband service.

It is noted that the local optical fibre networks, in which municipalities often have stakes, are a strong reality in this country, although such networks are not always open networks. In fact, according to data from the Association of Local Authorities and Regions of Sweden[323], there were 153 local optical fibre networks in 2006, of which 104 did not offer wholesale access (although 24 of these networks with no wholesale access had public financing from the Swedish government or from the EU).

With respect to the historic operator's investment, note is made of the project, announced on 13.03.2008, to achieve coverage of 1.5 to 2 million residential and business properties with very high-speed broadband services within a period of five years.[324] Television is considered an "anchor" for this investment, but online games and home security are also appealing business areas. TeliaSonera accepts the possibility, under this project, of collaborating with municipalities, building owners and housing cooperatives.

The solutions envisaged for the "selective" upgrading of the network are varied, encompassing optical fibre connections with speeds exceeding 100 Mbps and VDSL2 over the copper network, with speeds between 30 Mbps and 70 Mbps.

It is noted that TeliaSonera's strategy involves covering the different broadband user segments using a diverse set of technologies, encompassing, in addition to fibre, VoIP, Ethernet, GRX and TDM. In any event, the key selling points of TeliaSonera's broadband seem to be its bundled offers, centred around IPTV. This is subject to this operator's growing investment in services which demand greater bandwidth and lower latency, such as games, content and media.

It should be reported that as the pace of broadband adoption was less than expected in certain regions of Sweden, TeliaSonera was forced to increase its monthly charge for FTS, which in turn contributed to increased fixed-mobile substitution.

Although it seems too early to assess the impact of vertical separation on NGA investment, PTS has been seen to be concerned about the fact that SKANOVA did not present, in addition to backhaul and dark fibre lines, any offer of bitstream access to fibre.

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[323] See Lokala bredbandsnat i Sverige ar 2006. En oversiktlig beskrivning av utbredning och verksamheter.

[324] http://www.teliasonera.com/press/pressreleases/item.page?prs.itemId=338043.

With regard to alternative operators, note is made of Comhem (a regional cable operator), Tele2 and, especially, Bredbandsbolaget[325], the second largest provider of broadband services in Sweden (supported over Ethernet, DSL and fibre technologies) and services of IP telephony, VOD and television.

Bredbandsbolaget's network covers about 450 thousand households, guaranteeing them 25% of the residential broadband market. Of these users, about 175 thousand use voice over IP services. Approximately 15 thousand companies also use this service provider. In terms of coverage, Bredbandsbolaget's network has the potential to serve more than two million households in over 70% of the Swedish territory. This coverage is developed in direct access using FTTx technologies (in 40% of cases) and xDSL over unbundled local loop (in 60% of cases).

An important element in the development of Bredbandsbolaget's network coverage has been the development of partnerships (see Figure 65).

Figure 65: Examples of partnerships to expand coverage

Partnership	Description
HSB	In August 1999, and B2 Breadband and HSB signed an agreement to install broadband in all apartments associated with HSB. HSB is the largest association of apartment owners in Sweden.
Municipality of Markaryd	In April 2005, B2 signed a 10-year agreement with the Municipality of Markaryd to offer broadband services using FTTx in 5,900 apartments.
Housing association in Linkoping	In May 2005, B2 signed a 10-year agreement with the housing association of Linkoping (Stangaataden) to offer FTTx broadband services in 14,000 apartments in Linkoping.
Akileus	In May 2005, B2 signed a 10-year agreement with the Akileus association to offer FTTx broadband services in 4,600 apartments in Gothenburg, Trollhattan and Boras
Municipal Corporation of Eidar	In March 2006, the operator established a partnership with the Municipal Corporation of Eidar to provide 100 Mbps broadband services to local community residents.

Source: Ovum and Point-Topic

Bredbandsbolaget sees considerable opportunity to expand and gain market share using LLU with ADSL2+ and VDSL2 technologies, even while it is estimated that 35% of all apartments in residential buildings with potential for FTTx have already been served by an

[325] Since July 2005, Bredbandsbolaget has been a wholly owned subsidiary if the Norwegian operator Telenor.

operator. That is insofar as, for isolated homes and small businesses (in areas with lower density), the development of FTTB is not possible and the costs for a FTTH type solution are much higher. As such, in spite of considering FTTx the definitive solution for residential buildings, Bredbandsbolaget sees opportunity in LLU for rapid entry with a low level of investment into markets where the fibre deployment is not possible.

According to this alternative provider, FTTX is the definitive future solution but will continue in co-existence with cable and LLU for a substantial time, also because the development of FTTx in Sweden is being held back due to a lack of access to dark fibre in backhaul, due to the creation of local monopolies by community networks and due to regulatory uncertainty.

It is noted that PTS, in one of its studies (Bohman and Blomdahl, 2008), took the view that the restrictions that the historic operator has applied to the sale of dark fibre to wholesale customers limits access to dark fibre and may be considered a manifestation of market power. Nevertheless, the regulator also took the position that municipal initiatives related to NGA have been manifesting a growing positive attitude towards providing wholesale access to dark fibre.

Currently, Bredbandsbolaget provides retail offers with speeds of up to 60 Mbps to 460 thousand households in sixty-five Swedish cities representing about 10% of total Swedish households, with coverage encompassing around 18% of all Swedish households, approximately eight hundred thousand households.

The case of Bredbandsbolaget illustrates the initiative and determination of OAO in developing solutions that enable the differentiation of service and drive gains in market share. In 1999, when Bredbandsbolaget began development of the FTTx network, Ethernet technology was not yet that developed for this type of use, the operational challenges involved in the passage of fibre were considerable and costs were much higher. However, in less than ten years, this operator has managed to establish a leading position for itself in the market.

Another interesting point is that even in a market with greater demand for high-speed broadband, where the definitive solution will be fibre-based, Bredbandsbolaget recognizes that, in the medium term, the FTTx offer will continue to coexist with the provision of cable and the offer of LLU-based xDSL.

In February 2010, TeliaSonera announced that it planned to modernise its broadband Internet access network, to offer broadband services with higher speeds. As such it selected

Ericsson to implement a "*EDA 1200*" solution based on VDSL2 technology. This agreement covers TeliaSonera broadband operations in Sweden, Norway and Denmark.

As a result of operator initiatives and of the measures taken by governments, as at the end of the first half of 2010, Sweden had the sixth highest FTTH penetration rate among the world's economies (with 12.9 accesses per 100 households).

In Sweden, the decision was taken to pursue the functional vertical separation of the historic operator in order to promote the deployment of NGA, while Portugal chose to conduct a timely, prior reflection in respect of this matter[326], which remains under review. However, in Sweden, as in the United Kingdom and Australia, initial results do not appear encouraging. On the other hand, the role played by local authorities has been more active in Sweden than in Portugal. In any case, in both countries the NRA's focus is evident, ensuring competitive conditions at different levels.

4.15 Summary of case studies

In short, it appears that the salient features of international experiences in the deployment of NGA are related to the role of the state, to the intervention of the NRA and the strategy pursued by the major operators.

With respect to the role of the state, this is important, primarily for the development of a transparent legal framework that promotes investment in NGA throughout the national territory, while simultaneously safeguarding the return on the investments made by operators and conditions of healthy and sustainable competition in the market.

In second place, the state may also participate actively in the deployment of NGA through:

a) Allocation of support to investment, primarily in rural and more remote regions, where the business plan is more risky (uncertain return) and the existence of future competition between operators supported over NGA is more difficult;
b) Direct participation in investment, including through PPPs, often involving local authorities or by granting of concessions for the installation and operation of NGA in rural areas.

With respect to the role played by the NRA, in particular in the EU context, these guarantee, through a transparent, stable and predictable regulatory environment, stemming from application of the EU framework and the market analysis process (and the consequent *ex ante* imposition of obligations), an appropriate framework for investment throughout the

[326] See point 6.2.3 on page 202

national territory and for the development of healthy competition; in particular, the following issues can be highlighted:

a) The need for NRA to prepare to address a set of current and anticipated regulatory challenges arising from the deployment of NGA, related in particular to: (a.1) the sufficiency or otherwise of *ex post* regulation as a deterrent to anticompetitive behaviour at retail (and even wholesale) level; (a.2) the mass use of bundle offers (analysis of costs, predatory practices, leveraging of SMP in adjacent markets, etc.); (a.3) *"net neutrality"* (levels of capacity and quality of service, free choice of services and non-discrimination) and (a.4) the relationship between regulatory predictability regarding the definition of relevant markets, *ex ante* imposition of obligations and market dynamics;
b) Promotion of investments in geographic areas where return is more doubtful, ensuring, meanwhile, compliance with the principles of promoting competition, transparency, safeguarding of conditions of non-discrimination and compatibility with European guidelines and case law in respect of "state aid";
c) Analysis of the need, feasibility and the conditions of implementation and operation with respect to possible vertical separation solutions (functional or structural) to accelerate investment in NGN/NGA and, at the same time, to ensure access to these networks according to terms of equivalence;
d) Implementation and supervision of the imposition of wholesale obligations which are considered necessary and proportional to ensure access to the NGA of the SMP operator(s) by alternative operators, particularly during the migration from traditional networks to these networks (e.g. access to ducts, access to dark fibre, offer of (unbundled) access to the fibre loop/sub-loop, active "*bitstream*" offer, physical (or virtual) co-location, publication of detailed migration plans; and
e) Implementation of a registration system of infrastructure (particularly useful in the cases of Portugal, France and Germany), sharing of infrastructure and future investment between operators, etc.

Regarding the strategies followed by the operators, it can be highlighted that investments seem to be driven, in a context of rapidly changing user needs, and especially in major urban centres, both by the initiative of the historic operators and the provision by competing providers of retail offers with high speeds.

With regard to rural and remote areas, the role of PPPs and projects funded by the State and community funds is further highlighted, given the more dubious return on investment.

5 The evolution of the European regulatory framework

In September 2010, the EC adopted three complementary measures to facilitate the deployment and take-up of fast and ultra-fast broadband in the EU.

The package consists of the EC Recommendation on regulated access to next generation networks (see 5.1), which offers regulatory certainty to operators of electronic communications, ensuring a proper balance between the need to encourage investment and the need to preserve competition; a draft Decision establishing a radio spectrum policy programme, aimed at ensuring, *inter alia*, the availability of spectrum for wireless broadband; and a Communication on broadband, which defines the best way of encouraging public and private investment in high-speed and ultra-fast networks.

The draft Decision establishing a radio spectrum policy programme established a five-year political programme to promote the efficient management of the radio spectrum and, in particular, to ensure availability of sufficient spectrum up to 2013 for wireless broadband (contributing significantly to bringing fast broadband connections to the inhabitants of remote areas and to making innovative services available across Europe). The efficient and competitive use of the spectrum in the EU will also be a good base for innovation in other policy areas and sectors such as transport and the environment.[327]

The Communication on broadband presents a coherent framework for achieving the objectives of the Digital Agenda in this respect and, in particular, defines the best way to incentivise public and private investment in fast and ultra-fast broadband networks. In its Communication, the EC calls on EU Member States to approve operational plans for broadband networks in relation to high and very high-speed networks with specific implementation measures, provide guidance on how to reduce investment costs and indicate how public authorities can support investment in broadband, including through better use of EU funds. Moreover, the EC and the European Investment Bank announced plans to create instruments for broadband financing[328].

5.1 EC Recommendation on regulated access to NGA

In September 2008, the EC launched a public consultation (considered crucial by the industry, in favouring legal certainty and promoting investment) on the draft Recommendation on NGA - "Draft Commission Recommendation on Regulated Access to

[327] MEMO/10/425
[328] MEMO/10/427

Next Generation Access Networks (NGA)"[329] - in order to compile information that would allow:

a) The issuance of guidance to NRA as to the regulatory treatment of NGA access;
b) The prevention of the fragmentation of the internal market;
c) The encouragement of investment in NGA;
d) The promotion of competition.

This consultation closed in November 2008 and, after incorporating changes suggested by respondents[330], a new version of the draft recommendation was released in June 2009, whereby it was re-submitted to consultation.[331]

Although the objectives in respect of the first consultation remain valid, the second draft included greater focus on promoting consistent implementation (in the EU) of remedies with respect to NGA, subsequent to Directive 2002/19/EC[332] of the European Parliament and of the conclusions of the European Council, held in March 2009.[333]

In May 2010, and after incorporating changes suggested by respondents to the second consultation and a long period of analysis and discussion, particularly with the ERG, the EC presented a provisional version of the Recommendation on NGA to BEREC.

In its opinion, adopted at its plenary meeting of May 2010 (2010b), on this new version of the EC draft recommendation, BEREC recognised it as an improvement over the previous version, but still requiring several amendments, particularly with regard to aspects concerning, among others, the primacy given to market analysis procedures in relation to the procedures established in the Recommendation, in terms of price flexibility and cost orientation, in terms of risk assessment and in terms of the possibility of price differentiation according to different geographical areas.

[329] http://ec.europa.eu/information_society/policy/ecomm/doc/library/public_consult/nga/dr_recomm_nga.pdf.

[330] See responses at http://ec.europa.eu/information_society/policy/ecomm/library/public_consult/nga/index_en.htm

[331] http://ec.europa.eu/information_society/policy/ecomm/doc/library/public_consult/nga_2/090611_nga_recommendation_spc.pdf.

[332] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:108:0007:0007:EN:PDF.

[333] In which the key role of telecommunications and broadband development was highlighted, in terms of investment, job creation and economic recovery.

The final version of the EC Recommendation on regulated access to next generation access networks (NGA)[334], formulated following comments from the EC's Communications Committee (COCOM), was released on 20.09.2010.

The goal of this Recommendation remains to accelerate the development of the single market, enhancing legal certainty and promoting investment, competition and innovation in the market for broadband services, particularly in the transition to next-generation access networks (NGA), ensuring a consistent regulatory approach in terms of the *ex ante* imposition of obligations by NRA on operators with SMP on Market 4 and on Market 5.

In particular, note is made of the guidelines, focusing, in respect of market 4, on types of "passive" access to NGA (access to ducts, access to the terminal segment (including cabling in buildings), unbundling of fibre loops and unbundling of copper sub-loops) and, in respect of market 5, on "active" access to NGA in the context of wholesale offers.

In this context, the Recommendation focuses mainly on remedial measures, establishing that the obligations of operators with SMP on markets 4 and 5 should be maintained and should not be invalidated by alterations to the network architecture and technology, unless the SMP operator agrees a suitable alternative with the operators benefiting from access to its network. Failing such an agreement, the NRA is bound to guarantee that alternative operators are advised, a least 5 years in advance (or less if fully equivalent access is provided at the point of interconnection), prior to any de-commissioning of points of interconnection, such as the local loop exchange.

Also in this context, it is noted in particular that the NRA is likewise bound to guarantee a transparent framework for the migration of copper networks to fibre networks, especially in relation to the procedures adopted by the SMP operator related to operating support systems and to the provision of timely and relevant information to alternative operators.

Table 8 Possible obligations to be applied in Market 4

Access to civil engineering infrastructure of the SMP operator	Access should be provided in accordance with the principle of equivalence. Based on a reference offer. NRAs should, in accordance with market demand, encourage, or, where legally possible under national law, oblige the SMP operator, when building civil engineering infrastructure, to install sufficient capacity for other operators to make use of these facilities. NRAs should work with other entities with a view to establishing a data-base, accessible to all operators, containing information on geographical

[334] COMMISSION RECOMMENDATION of 20/09/2010 on regulated access to next generation access networks (NGA) http://ec.europa.eu/information_society/policy/ecomm/doc/library/recomm_guidelines/nga/pt.pdf

	location, available capacity and other physical characteristics of all civil engineering infrastructure which could be used for the deployment of optical fibre networks.
Access to the terminating segment in the case of FTTH	Access must be ensured in accordance with the principle of equivalence and at cost-oriented prices. Provision of detailed information on access network architecture. Access to the distribution points of the terminating segment of the access network, determined following consultation with potential access seekers. NRAs should, in accordance with market demand, encourage, or, where legally possible under national law, oblige the SMP operator to deploy multiple fibre lines in the terminating segment.
Unbundled access to the fibre loop in the case of FTTH	Mandatory (except in geographic areas with alternative infrastructures and competitive access offers) and cost-oriented prices (considering also investment risk) assess by the NRA. Given, normally, at the Metropolitan Point of Presence and complemented with site/resource sharing and backhaul. With conditions established in the RUO. In cases of co-investment, the NRA should examine whether the capacity of installed ducts is sufficient for third parties and whether the co-investors are effectively competing on the downstream market.
Access obligations in the case of FTTN	Obligation of unbundled access to the copper sub-loop, at cost-oriented prices Supplemented, where appropriate, by backhaul measures (fibre and Ethernet) and by non-discriminatory access to facilities for co-location, or in their absence, equivalent co-location. With conditions established in the RUO.

Table 9 Possible obligations to be applied in Market 5

VDSL Wholesale Supply by SMP operator	The supply of wholesale broadband access over VDSL should be considered as a chain substitute to existing broadband access over copper-only loops and should be maintained as a remedy.
Time interval between launch of wholesale and retail products	The NRA should oblige the SMP operator to make new wholesale broadband access products available at least 6 months before the SMP operator begins selling its own retain products (unless there are other effective safeguards to guarantee non-discrimination).
Enabling competition in retail services through NGA wholesale products	NRAs should in principle impose cost orientation (unless equivalence of access is guaranteed by other means, for example through functional separation or other forms of separation) on wholesale products, that best reflect in terms of bandwidth and quality the technological capabilities inherent in the NGA infrastructure
Bitstream access	Where NRAs consider that, in a given geographic area, there is effective access to the unbundled fibre loop of the SMP operator's network, NRAs should consider removing the obligation of wholesale bitstream access in the area concerned.
Competition in cases of co-investment	In cases of co-investment, the NRA should examine whether the capacity of installed ducts is sufficient for third parties and whether the co-investors are effectively competing on the downstream market.

5.2 Community guidelines on state aid

In September 2009 the EC published a Communication, "Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks"[335], in the context of the European Economic Recovery Plan[336] of 2008, where the aim should be to reach 100% coverage by high-speed internet by 2010 for all citizens, supported by overall financing from the EC totalling 1.02 billion euros.[337]

These guidelines - in line with the "Altmark" criteria[338] - focus on the allocation of state aid to broadband projects and NGA[339], emphasizing aspects related to the reasoning for public intervention to accelerate NGA deployment, to type of public intervention which is desirable and the assessment of compatibility of State aid with the EU regulatory framework.

In respect of the grounds for **public intervention to accelerate NGA deployment**, while state intervention for the deployment of broadband infrastructure has focused on rural areas (with low population density and high capital costs) or economically underdeveloped areas (with limited ability to pay for services), the economic conditions of the NGA model discourage deployment not just in sparsely populated areas, but also in certain urban areas.

In fact, the main problem affecting the rapid and widespread deployment of NGA seems to be cost and, to a lesser extent, population density. Accordingly, from the standpoint of public authorities, intervention would be justified to ensure that areas considered by operators as unprofitable benefit from the substantial positive effects of NGA and do not fall victim to a new (and/or further) digital divide.

It is in this context that public authorities shall have the right to intervene under certain conditions and in certain areas to address issues of social cohesion and regional

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[335] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2009:235:0007:0025:EN:PDF.

[336] Communication from the Commission to the European Council, COM (2008) 800.

[337] Applied through the “European Agricultural Fund for Rural Development (EAFRD). Part of this amount will be used for deploying broadband infrastructures in rural areas to help rural areas get online, create new jobs and help business grow further", according to the EC's Guidelines.

[338] Judgement of 24 July 2003. - *Altmark Trans GmbH* and *Regierungspräsidium Magdeburg* vs. *Nahverkehrsgesellschaft Altmark GmbH*, and *Oberbundesanwalt beim Bundesverwaltungsgericht*. - Preliminary ruling request: *Bundesverwaltungsgericht* - Germany - Regulation (EEC) No. 1191/69 - Operation of urban, suburban and regional scheduled transport services - Public subsidies - Concept of State aid - Compensation for discharging public service obligations. - Case C-280/00.

[339] For the purpose of this document, NGA networks are access networks which consist wholly or in part of optical elements and which are capable of delivering broadband access services with enhanced characteristics (such as higher speeds) as compared to those provided over existing copper networks.

development or to correct a market failure, when it can be demonstrated that private investors do not intend to deploy NGA networks in these areas over the next three years.

Regarding **types of public intervention**, given that majority of the cost of deploying fibre network consists of civil engineering works, in accordance with the regulatory framework for electronic communications, Member States may decide, for example, to facilitate the process of acquiring rights of way or require network operators to coordinate their construction works and/or share some of their infrastructure. They may also stipulate that optical fibre links be installed in new constructions (including new water, energy, transport or sewerage networks) and/or new buildings.

For the purposes of **assessing state aid for NGA**, areas where such networks do not exist now and where it is unlikely that such networks will be constructed by private investors and be fully operational in the near future, should be considered NGA "white areas"; areas with only a single broadband network operator are considered "grey areas" and areas with at least two providers of broadband services are "black areas" (areas currently considered competitive).

The EC accepts that financial support may be provided to the supply of broadband services in white areas and, where necessary and justified (especially in terms of market failure and or territorial cohesion) in grey areas.

In terms of the compatibility of aid with the EU regulatory framework, the EC shall apply the balance test. That is, in assessing the proportional character of a notified measure, it will assess whether conditions are fulfilled in respect of the detailed mapping and coverage analysis, open tender process, most economically advantageous proposal, technological neutrality, use of existing infrastructure, wholesale access obligations, benchmarking pricing exercise and claw-back mechanism - that is, whether conditions are aligned with the "Altmark criteria".

In exchange for receiving state aid, the beneficiary should be required to provide third parties with effective wholesale access for at least seven years. In particular, the access obligation imposed should also include the right to use ducts or street cabinets so that third parties may have access to passive and not only active infrastructure.

An "open access" obligation is all the more crucial in order to deal with the temporary substitution between the services offered by existing ADSL operators and those offered by future NGA network operators. An open access obligation will ensure that ADSL operators can migrate their customers to a NGA network as soon as a subsidised network is in place

and thus start planning their own future investments without suffering any real competitive handicap.

Moreover, in setting the conditions for wholesale network access, Member States should consult the relevant NRA. NRAs are expected in the future to continue either to regulate *ex ante* or to monitor very closely the competitive conditions of the overall broadband market and impose where appropriate the necessary remedies.

In addition, irrespective of the type of NGA network architecture that will benefit from State aid, it should support effective and full unbundling and satisfy all different types of network access that operators may seek (including but not limited to access to ducts, fibre and bitstream).

In this respect, the EC notes that "multiple fibre"[340] architecture allows full independence between access seekers to provide high-speed broadband offers and is therefore conducive to long-term sustainable competition. In addition, the deployment of NGA networks based on multiple fibre lines supports both "point-to-point" and "point-to-multipoint" topologies and is therefore technology neutral.

Finally, it is good to highlight that the EC communication provides for a *"claw back"* mechanism, to compensate the State in the event that financial results exceed forecasts.

5.3 The position of the ERG/ BEREC

In October 2007, the ERG published an opinion requested by the EC, *"ERG Opinion on Regulatory Principles of NGA"*, setting out the ERG's Common Position on the regulatory approach to NGA[341]. This document examines and discusses (two) scenarios of NGA deployment (FTTC and FTTH/B) according to their economic and regulatory aspects, including the implications for the definition of retail relevant market 1[342] and 2[343] and wholesale markets 11[344] and 12[345], also defining a broad set of principles and guidelines regarding (any) imposition of obligations in these markets (in the context of the outlined scenarios) as well as a set of procedures to be adopted in migration to NGA.

[340] FTTH topology with various optical fibres installed in parallel (per house/customer).

[341] http://erg.ec.europa.eu/doc/publications/erg07_16rev2_opinion_on_nga.pdf.

[342] Market 1 - Access to the public telephone network at a fixed location for residential customers

[343] Market 2 - Access to the public telephone network at a fixed location for non-residential customers

[344] Market 11 - Wholesale unbundled access (including shared access) to metallic loops and sub-loops for the purpose of providing broadband and voice services, now Market 4.

[345] Market 12 - Wholesale broadband access, now Market 5.

Following this common position, in June 2009, the ERG published its "Report on Next Generation Access - Economic Analysis and Regulatory Principles[346]", with the aim of verifying the type of strategies followed in the development of the NGA since the publication of the document "ERG Opinion on Regulatory Principles of NGA". The ERG also sought to verify the respective regulatory "responses" of the NRA, presenting a set of summary conclusions in respect of investment in NGA, obligations of access and investment ladder, measures to control prices and co-investment projects.

According to this report, in the area of **investment**, a tendency is observed in certain countries towards a "migration" from FTTC to FTTH (in terms of deployment projects), although both scenarios remain valid (also taking into account existing networks on the ground). It has likewise been confirmed that the deployment of fibre projects tends to enhance economies of scale and scope, with limited replicability (by alternative operators), thereby exacerbating certain economic bottlenecks.

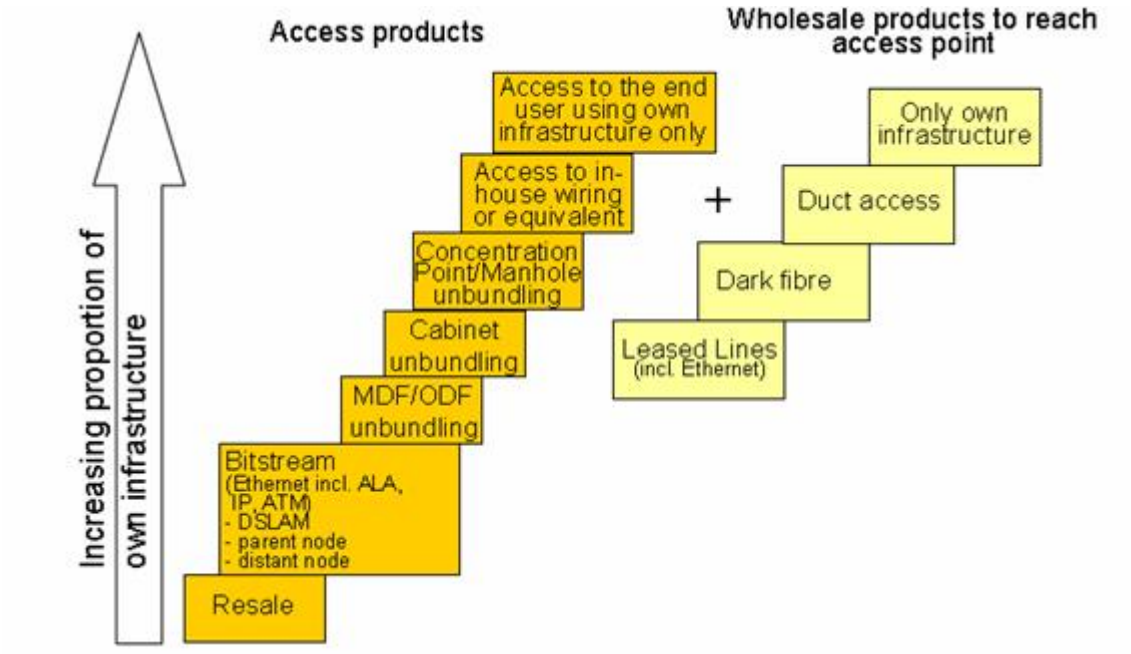
According to the ERG, the distinction between Market 4 and Market 5 remains valid, even if developments are expected in terms of new bitstream products which offer additional features (e.g. "advanced bitstream", supported over optical fibre).

With respect to **access obligations and the investment ladder**, the ERG states that the paradigm of the investment ladder in infrastructure[347] appears to remain valid, but with changes in the relative importance of the rungs (see Figure 66).

[346] http://erg.ec.europa.eu/doc/publications/erg_09_17_nga_economic_analysis_regulatory_principles_report_090603_v1.pdf.

[347] The ladder of investment in infrastructure is a regulatory model developed, among others, by Prof. Martin Cave. It is assumed that investment is made step by step by new entrants. In order to allow them to gradually invest in their own infrastructure, a chain of (complementary) access products would be required to build a customer base by offering their own services to end-users.

Figure 66. NGA Investment Ladder.



Source: ERG (2009).

The left side of Figure 66**,** shows the different access products (linked to the type of access and the access points). This model is applicable to both the copper and fibre network. The concentration point is an access point located between the street cabinet and the building (possibly inside the building). When an alternative operator ascends the ladder, it will have to progressively invest more in its own infrastructure, but not all rungs have to be used (there may be "jumps", for example, if an operator co-located for LLU access decides to develop its own optical fibre access/infrastructure). Depending on the development scenario to be implemented - FTTC or FTTB/H - different rungs on the infrastructure investment ladder are relevant.

The right side of Figure 66 shows the different wholesale products on the access/concentration network that an alternative operator can use to reach the access points (to interconnect its network).

Various combinations of access products and wholesale products are possible, depending on the network architecture and topology. However, the highest level "Direct access to the end-user") can only be achieved through use of own infrastructure (e.g. optical fibre) and access to ducts (possibly with their construction, where no infrastructure is available).

According to the ERG, the promotion of effective competition at the deepest level of the network - effective competition in terms of infrastructure - encourages investment and continues to be the proper attitude of the NRA, although the balance between competition in infrastructure and its economic viability can be different in different Member States,

depending on their (regional) characteristics and specifications[348]. When replication of access is not feasible, the promotion of competition in terms of services should be a (priority) objective for the NRA, whereas, while conditions remain competitive (in the various markets), the "mere" development of NGA is no reason to change the regulation of currently available services.

With respect to price control measures, new pricing models suggested by historic operators (loyalty periods, initial payment, volume discounts) require verification to ensure the principle of non-discrimination and prevent margin squeeze. Also according to the ERG, to encourage efficient investment, a reasonable rate of return needs to be calculated, including a risk premium to reflect the risks involved, whereas existing methodologies remain valid.

Moreover, the NRA may facilitate investment planning, instilling regulatory predictability and stability, by announcing regulatory strategies and determining the duration of the regulatory period (taking into account, in the period of price calculation, the technology and the market's development), thereby achieving a balance between certainty and flexibility.

The ERG also notes that co-investment projects, in their various forms, limit the risk by reducing the capital expenditure of all parties involved.

Subsequently, in March 2010, BEREC (successor to the ERG) published a new report on NGA, "Next Generation Access - Implementation Issues and Wholesale Products" (BEREC, 2010a), following up on the ERG Common Position of 2007 referred to above. This report addresses, among other aspects, current practices (also reinstating some principles of best practice previously prescribed by the ERG - see below) relating to wholesale products (Markets 4 and 5 and infrastructure, such as access to ducts) currently available and in an environment of NGA development.

Recognizing that it was too early to conduct a detailed analysis in this area, given the early stage of implementation of regulatory decisions in this respect and the early stage of NGA deployment, BEREC considers that all the best practice principles as identified in the 2007 document ERG (07) 53 "Report on ERG Best Practice on Regulatory Regime in Wholesale Unbundled Access and Bitstream Access" remain valid[349] and should be also applied. This document describes best practices on regulatory regimes in wholesale infrastructure access

[348] Indeed, it is likely that one of the most effective strategies for the development of NGA is the use of various technologies to provide specific services with varying characteristics according to the site, leading to a market - in EU Member States and in different regions within States - with a heterogeneous structure, given that the development of NGA does not take place at the same pace and in the same way in all locations.

[349] http://www.irg.eu/streaming/erg_07_53_wla_wba_bp_final_080604.pdf?contentId=544650&field=ATTACHED_FILE.

market as well as the wholesale broadband access market, setting out a broad set of "best practices" incorporated into three key aspects:

a) Operational: Quality of Service - associated with wholesale access is a key issue and is particularly crucial for process industrialisation. On one hand this has a direct impact on the service provided to the end-user and on the other hand it is a key factor for process optimisation and rationalisation for operators.

   There should be reasonable certainty that entrants will be able to compete according to the same conditions, whereby there should be assurance that access products will be of reasonable quality and that service levels (delivery times, cut-off period, repair times etc.) will be reasonable and comparable with that provided to the SMP player's own business units (especially its "retail arm").

b) Functional: Migration and Richness of reference offers - two main functional issues are essential to allow new entrants to progressively extend their own network closer to the customer:
   b.1) Appropriate migration processes that allow them to pass from one wholesale access product having a given number of access/interconnection points to another wholesale access product requiring more access/interconnection points;
   b.2) Completeness of reference offers that allow them at least to offer the same service as the historic operator and richness that render them able to differentiate their services from that of the historic operator’s retail arm and even to be the first mover by offering new and innovating services.

c) Economic: Pricing issues - prices of wholesale broadband offers are set to create incentives for both SMP player and new entrants to invest in broadband infrastructure.

   The level at which prices of wholesale broadband offers are set, compared to each other and to the historic operator retail offers, should create incentives for new entrants to climb the ladder of investment. Access transparency and non-discrimination obligations may help to create the necessary conditions. Nevertheless, price control obligation is required to guarantee fair and sustainable competition.

In terms of good practice, in the report of 2010, it is noted that the powers conferred on the NRA by the Framework Directive, allow them to impose specific obligations on wholesale markets, in respect of NGA. This indicates that, in addition to the existence of a reference

offer in this/these market(s), wholesale operator customers should also have access to relevant information about the development of new infrastructures or technologies in their geographic area of interest; as such, a mechanism needs to be created for the publication of this information. Likewise, information regarding the discontinuation of services/infrastructure should be announced in advance and in an appropriate manner, to avoid situations of discrimination.

Finally, it is reiterated that BEREC (2010b) adopted an opinion, in response to the request of the EC, on the 3rd version of the EC on Recommendation on NGA.

6 The situation in Portugal

This chapter aims to characterize the current situation regarding the development of NGA in Portugal, with particular focus on state initiatives (government and community networks), the actions of ICP-ANACOM and the activities of the operators and service providers of electronic communications (supported over NGA).

Nevertheless, it is stressed that this development takes place in a context where, at the European level, both the EC and ERG/BEREC have presented concrete positions on the regulatory framework governing NGA.

6.1 Government Initiatives

6.1.1 Establishment of general objectives

Under Resolution of the Council of Ministers no. 120/2008 of 30 July, the Portuguese government has[350]adopted investment in NGA as a strategic priority for the country, establishing as key targets the connection to NGA of:

a) One million users by 2010;
b) All primary and secondary schools and all public justice services by 2010[351];
c) All public hospitals, health centres, museums and libraries and all public institutions of higher and polytechnic education by 2009.

These objectives are in line with the approach adopted in the European Union, following the EC Communication "A European Economic Recovery Plan", Com (2008) 800[352], which recognizes that accelerating migration to NGA is key to Europe's recovery from the current economic and financial situation.

6.1.2 Legislative Developments

Based on intense advisory work undertaken by ICP-ANACOM, Decree-Law no. 123/2009 of 21 May[353] established the regime applicable to the construction, access and installation of electronic communications networks and infrastructure. This legislation contains a set of provisions designed to ensure open access to infrastructure, both existing and to be

[350] http://dre.pt/pdf1sdip/2008/07/14600/0511005113.PDF.

[351] The target set out in the *Plano Tecnológico da Educação* (Education Technological Plan) was brought forward by one year. http://www.pte.gov.pt/pte/PT/EspaçoMedia/Notícias/002661?idNoticia=002661

[352] http://www.broadbandeurope.eu/Lists/DocumentsData/Attachments/66/European%20Economic%20Recovery%20Plan%20COM%2020081126_EN.pdf

[353] http://dre.pt/pdf1sdip/2009/05/09800/0325303279.pdf.

constructed, whose characteristics make it suitable for housing electronic communications networks.

This legislation also seeks to encourage construction, installation and access to infrastructure — with a technologically neutral approach — in the possession of entities in the public domain[354], utilities or other entities possessing infrastructure installed in the public domain of the State, autonomous regions and local authorities.

As such, a rule of" open access" has been defined consisting of non-discriminatory access to ducts, masts and other facilities owned by public or private bodies which, even though operating in other sectors, are important to the removal or mitigation of barriers to the installation of electronic communication networks.

The Decree-Law also established rules to facilitate the coordination of underground intervention (especially in respect of the relationship between operators and local authorities), including the obligation to give notice of the execution of works which enable the construction of infrastructure and allow companies/operators to take part in these interventions.

At the same time, provision was made for the establishment of a Centralized Information System (CIS)[355] which will contain record information on infrastructure owned by the above entities, to ensure open and effective access by all operators/electronic communications companies to infrastructure[356]. Following a public consultation process launched by ICP-ANACOM, the format for the provision of elements of the CIS was defined[357] and on 23/11/2010 an international tender was launched to develop the system.[358]

Also in consequence of the Resolution of Council of Ministers referenced above - which determined the need to implement measures (*see* section 6 point d) to eliminate barriers to the roll-out of optical solutions in connection with NGA, including the introduction of the appropriate changes to the technical regulations currently in force -, Decree-Law no.

[354] Covering the State, autonomous regions and local authorities, entities that are subject to the supervision or oversight thereof, and which perform administrative functions, regardless of their corporate nature and public companies.

[355] The CIS is applicable: a) to the State, autonomous regions and local authorities; b) All entities under the authority or supervision of bodies of the State, Autonomous Regions and local authorities, performing administrative tasks, regardless of their entrepreneurial nature, as well as to public companies and concessionaries, particularly those active in the field of infrastructure for roads, railways, ports, airports, water supply, sewerage, and transport and distribution of gas and electricity; c) Other entities that own or operate infrastructure which is part of the public domain of the State, autonomous regions and local authorities.

[356] Pursuant to that set forth in Resolution of Council of Ministers no. 120/2008 of 30 July. See http://dre.pt/pdf1sdip/2008/07/14600/0511005113.PDF.

[357] http://www.anacom.pt/render.jsp?contentId=999787.

[358] http://www.anacom.pt/render.jsp?categoryId=339052.

123/2009 has also established legal regimes applicable to ITUR and alterations to past and future ITED installations.

As such, Decree-Law no. 123/2009 has established clear rules governing ownership and use of cables (including optical fibre) inside buildings and guarantees open access thereto (see articles 62 and 63), establishing, in particular, that the management and conservation of ITED integrated into the common parts of buildings falls to the respective administrations (article 62, paragraph 2).

Regarding the occupation of spaces and piping, this Decree-Law sets out that these must be sized by the designer to meet communication needs and according to the expected number of users of the building (article 61, paragraph 3), whereas the occupation of spaces and piping by means deemed to be unjustified is prohibited, taking into account services to be provided and technologies to be made available (article 61, paragraph 4), which contributes *ab initio* to safeguarding the possibility of installing optical fibre.

Moreover, modifications to be made in building which have already been constructed must necessarily support the entry and passage of the optical fibre cables of various operators and their links to existing electronic communications infrastructure, whereas the first operator to access the building to install this type of infrastructure must ensure a number of provisions with a view to this objective (article 104).[359]

It is noted (also according to article 104), electronic communications infrastructures between electronic communications companies shall be shared in a reciprocal fashion, observing the principles of transparency, non-discrimination and cost-orientation of prices.[360]

It is set forth in article 104, paragraph 2, that for the purpose of sharing the installed infrastructure, the sharing point must be located inside the building, in the building's general distribution frame or close thereto. If this is not possible for technical reasons, paragraph 3 of this Article safeguards the ability of operators to find an alternative solution, namely by

[359] *a*) The set up of the whole building rising main with an appropriate capacity to supply electronic communications services to all dwellings of the building;

b) b) The existence of customer connection points enabling each electronic communications company to connect each dwelling by their own resources, through a connection to the rising main;

c) The possibility of sharing the infrastructure set up, regardless of the type of network structure, by other electronic communications companies that wish to provide electronic communications services on the basis of optical fibre technology.

[360] Taking into account the increase of costs incurred by the electronic communications company when setting up a shareable infrastructure, under the following terms:

a) The first operator to access the building shall bear in full the cost of constructing the infrastructure;

b) The second operator to access the building may connect to the infrastructure developed by the first operator by paying the latter 50% of the cost, and the following operators may also connect to that same infrastructure by bearing costs in the corresponding proportion.

locating the sharing point in a different point in the building or at the building's entrance, in the cabinet of access to electronic communications infrastructures, or by using the collective urban development pooling point.

The conditions relating to ITUR (see paragraphs 3 and 4 of article 32. º), with respect to modifications to installed telecommunications infrastructure, are in line with those applied to ITED, applied to buildings - paragraphs 1 and 2 of article 64

However, distinction must be made from regime of access to public ITUR (where, the installation of cabling and occupation may be subject to a fee, oriented to costs) and access to private ITUR (which cannot be made subject to any remuneration, financial or otherwise, by the owners or administration of groups of buildings). Furthermore, exclusive access agreements are prohibited, and any agreement which is entered into in violation of the established regime shall be null and void.

Subsequently, Decree-Law no. 258/2009 of 25 September, extended the access obligations set out in Decree-Law no. 123/2009 to electronic communications companies and entities in possession of infrastructure suitable for housing electronic communications networks that are used by sector businesses, whereas ICP-ANACOM has been granted the resources which it needs to conduct the inspection activities with which it is charged pursuant to Decree-Law no. 123/2009.

6.1.3 Protocols with operators

In order to achieve the objectives established in 2008, a protocol was signed in January 2009[361] between the government and PT Comunicações S.A. (hereinafter PTC), Sonaecom, SGPS (abbreviated to Sonaecom), ZON Multimédia - Serviços de Telecomunicações e Multimédia, SGPS, S.A. (hereinafter ZON) and Oni Communications (DST will sign this protocol subsequently). Vodafone Portugal did not sign the protocol on the grounds that, in their case, it is not yet in a position to commit to investment in NGA in Portugal[362], but may subscribe to the protocol at a later date.[363]. Furthermore, under the protocol itself, it remains open to all investors in NGA to join it if they see fit.

In this protocol, the government committed itself to:

[361] http://www.portugal.gov.pt/pt/GC17/Governo/Ministerios/MOPTC/Intervencoes/Pages/20090107_MOPTC_Int_Comunicacoes_Nova_Geracao.aspx.

[362] http://aeiou.exameinformatica.pt/vodafone-nao-assina-protocolo-da-fibra-optica=f1001492

[363] On 15.06.2010 Vodafone announced the introduction of "triple play" - voice, Internet and TV - fixed service supported over their own optical fibre network. This service provides access speeds of up to 300 Mbps. The service is available in some areas of Lisbon and Almada. It is expected that 200,000 homes will be reached in the metropolitan areas of Greater Lisbon and Greater Porto.

a) Promoting the formulation of appropriate legislative measures in order to open ducts, regulate networks inside and outside of buildings and develop a centralized information system, enabling operators to obtain information about the location of ducts;
b) Creating a line of credit, available to all investors in NGA, with a minimum value of 800 million euros;
c) Generating incentives for investment in NGA.

For their part, operators have committed to invest about one billion euros and to bring forward, to 2009, the allocation of resources that make it possible for 1.5 million users to be connected to an optical fibre network.[364]

6.1.4 High-speed networks in rural areas

There are parts of the national territory, mainly rural, where it is unlikely that, in the near future, the market will generate the incentives necessary for operators to invest in new infrastructure for the provision of broadband access services (especially high-speed), e.g. due to factors critical to the investment, such as population density (which determines the cost of bringing the network to households) and socio-economic factors such as age, education level and *per capita* income (which determine the potential revenue generated by the network).

Therefore, public incentive to deploy NGA (also) in rural areas can contribute to equality of opportunity for all citizens, promoting info-inclusion and the development of human capital and contributing to the creation of externalities in rural development policy at the level of employment, growth, competitiveness and sustainability of the industries located in these areas. It is due to this broad conviction that the European economic recovery plan[365] (EERP) established the goal of ensuring that all Europeans have access to broadband in 2010.

As already mentioned, the EC has recently advanced with additional funding of one billion euros to fill gaps in broadband found in the EU's rural areas; as such, Portugal has been granted a budget of 50 million euros which, according to the government, will be applied exclusively to NGA in rural areas.

Accordingly, and considering NGA as a generator of economic opportunities, training and development, the government launched five Public Tenders for the installation and operation of "High-Speed Networks in Rural Areas", covering one hundred and forty municipalities,

[364] http://www.povt.qren.pt/cs2.asp?key=moptc&vtexto=1&idcat=1926.~
[365] http://ec.europa.eu/news/economy/081127_1_pt.htm

grouped into five zones: North, Centre, Alentejo and Algarve, Azores and Madeira. As such, in May 2009, it launched the first tender for the Centre zone. This was followed by tenders for the areas of the Alentejo and Algarve and the North (in early July 2009) and, finally, in late July 2009, for the Azores (A.R. Azores) and for the Autonomous Region of Madeira (A.R. Madeira).[366]

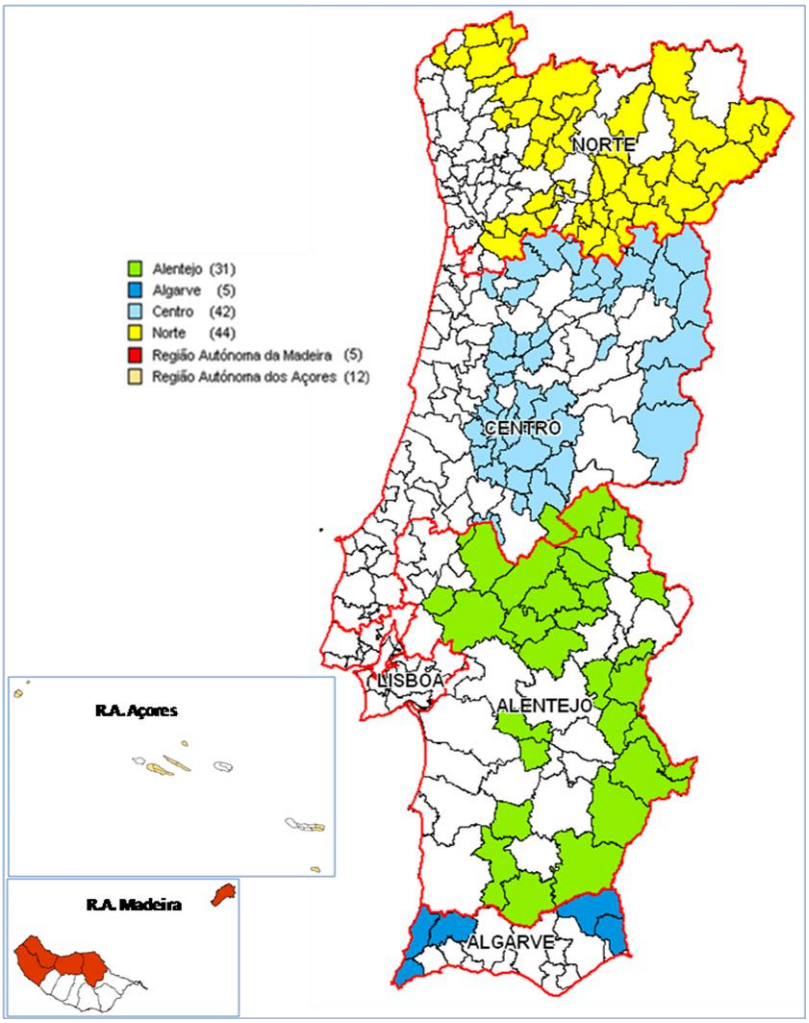
It is noted that in each of these areas, the municipalities covered are those with no competition at retail level, particularly those without cable network coverage and/or coverage by (co-located) alternative operators - *see* Figure 67.

In accordance with the tender specifications, the winning entity will be bound to ensure minimum coverage of 50% of the population of the geographic area of each of the municipalities included in the tender within twenty-four months, and guarantee a minimum speed 40 Mbps (downstream) per end-user.

Besides these conditions, the high-speed network should be operated as an open network, and a wholesale offer shall be provided for a period of twenty years to ensure non-discriminatory access to the network for all operators and providers of electronic communications services interested in their use to provide services to end-users. Indeed, the technical and financial conditions of wholesale access to high-speed electronic communications networks should conform at all times with the principles of transparency and non-discrimination, ensuring full compliance with competition rules.

[366] http://www.anacom.pt/render.jsp?categoryId=331870.

Figure 67 Areas and municipalities in the tenders for high-speed networks



Source: ICP-ANACOM

The tenderers submitting winning bids were DSTelecom (Alentejo and Algarve Zone and North Zone) and Viatel (in the Central zone and in the areas of the autonomous regions), whereas the signing of the contracts is subject to approval by the EC of state aid, expected to have an overall value of 106.2 million euros.

According to the winning proposals, a total number of around 242 thousand households will be passed in the municipalities covered. The cost of passing each household, to meet the established coverage criteria, is estimated at between 651 euros and 1630 euros, with this difference mainly resulting from whether or not use is made of existing ducts, masts and buildings of the historic operator or other entities, since, according to various estimates, civil works account for about 70%[367] of a (NGA) network's development cost.

Analyzing the cost per passed household, it can be seen that the values are between two to four times lower than that estimated for rural areas in the study conducted for ICP-ANACOM

[367] JP Morgan, OVUM.

by Ovum (Ovum 2008). This study's assumptions were based on the following set of premises with respect to rural areas: a) 5% of rural households passed in the first year and an increase of about 10% annually, reaching 50% after four years; b) 14% of households connected in the first year and 22% after four years; and c) inclusion of the Drop[368] in investment spending, i.e., the client connection (vertical infrastructure) to the operator's network was considered as an investment.

This difference between the values of the study and those proposed by the tenderers may be due to the fact that the value in the tenders only include the coverage of households, where the tenderers take coverage to mean all households within 200 metres from the optical distribution point, while the study estimated the costs of passing each household. Another reason may be due to greater variability in prices at the time of the study, when the technology was in an introductory phase.

The process of launching the tenders for the promotion of next generation networks was widely publicized, with all conditions put in place to achieve the best offers for the areas concerned. In this context, the Portuguese government still saw fit to launch a public consultation[369], taking place until 25.11.2010, with a view to the achievement of two goals.

a) To enable entities with available infrastructure, or with infrastructure to be made available in the period between 2010-2012, which could provide support for the development of the networks covered by the tenders (North, Centre, Alentejo and Algarve, Azores and Madeira) to manifest their availability;

b) To compile data on how the entities planning to use the wholesale services to be made available by the winning tenderers intend to use such services for the provision of final services to residential customers in these areas.

6.2 The actions of ICP-ANACOM

A summary is given below of the activities undertaken by ICP-ANACOM in respect of NGN/NGA. In addition to its role advising the government in the preparation of legislation, particular note is made of ICP-ANACOM's work with respect to market analyses and the launch of public consultations, undertaken with a view to eliminating and/or reducing horizontal and vertical barriers to the deployment of NGA and ensuring proper migration from traditional networks.

[368] The 'Drop' network interconnects the ONT in the customer's premises to the distribution fibre.

[369] http://www.anacom.pt/render.jsp?contentId=1056247

Note is made again of the study, referred to above, which was conducted by Ovum for ICP-ANACOM (Ovum2008), in which a broad and significant set of issues calling for careful attention in the deployment of NGN was examined in the light of specific national conditions and made subject to recommendations.

It should be noted that there remains an important set of regulatory issues and challenges, raised in an environment of NGA development, where future business models are not entirely predictable[370], including:

a) Will *ex-post* regulation be enough to deter any anti-competitive behaviour at retail level?
b) How to address issues related to the widespread provision of bundled offers (cost analysis, predatory practices, leveraging of SMP in adjacent markets, etc)?
c) How to specifically address the problem of *"*net neutrality*"* and, in particular, what can be done to (c.1) maintain appropriate and pre-defined levels of capacity and quality of service in access to the Internet (c.2) ensure that end-users are free to choose content, services, applications, hardware and software and (c.3) to safeguard the application of non-discriminatory access to the Internet by the end user?[371]
d) How to articulate regulatory predictability associated with a stable regulatory framework in terms of the *ex-ante* definition of markets with an accelerated and often disruptive dynamic of markets, technologies and services?

6.2.1 Definition of markets and public consultations

By determination of June 2008, ICP-ANACOM approved the draft of a public consultation on "Markets of wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location and of Wholesale broadband access[372] - Definition of the product markets and geographic markets, assessment of SMP and the imposition,

[370] http://ec.europa.eu/information_society/activities/foi/library/docs/final-report-nosec-clean.pdf.

[371] The document of Norway's NRA entitled *"Network neutrality - Guidelines for internet neutrality"* of February 2009 develops an interesting discussion of these points (see http://www.npt.no/ikbViewer/Content/109604/Guidelines%20for%20network%20neutrality.pdf).

[372] Broadband Internet services are characterized by the provision to end-users of asymmetric and symmetric speeds, in the downstream direction (i.e. originating on the network and destined to the customer) are above 128 Kbps.

maintenance, alteration or removal of regulatory obligations"[373]. The report on this public consultation[374] was published in December 2008.

By determination of January 2009, and taking into consideration comments submitted by the EC[375], approval was given to the final decision on the definition of product and geographic markets, SMP assessment and the imposition, amendment or withdrawal of regulatory obligations in markets 4 and 5[376].

In relation to the Market 4, of national geographic scope, it should be highlighted that:

a) The relevant product market covers access to all products regardless of technological support, including optical fibre products and excluding products of fixed broadband wireless access (*Fixed Wireless Access* - FWA);
b) Grupo PT holds SMP on this market, determined based in particular on the criteria of market shares, barriers to entry and expansion and lack of potential competition;
c) ICP-ANACOM intends to maintain the remedial measures (obligations) imposed on Grupo PT and refers to the possibility of adding to them with the inclusion of access to the optical fibre network and rules governing migration from copper to optical fibre.

In relation to Market 5 (see Figure 68), which is not now nationwide, it is highlighted that:

a) The product market of retail broadband access services is made up of broadband access through xDSL, cable modem and optical fibre, provided to residential and non-residential customers;
b) The provision of wholesale broadband access over copper line (including internal supply) and using cable modems belong to the same relevant market. As regards the LLU market, optical fibre products are included, while broadband wireless access products are excluded;

[373] http://www.anacom.pt/streaming/mercados4_5deli26062008.pdf?contentId=598976&field=ATTACHED_FILE.

[374] The report of the "Public Consultation and Consultation on the draft decision on the definition of the product and geographic markets, SMP assessment and the imposition, maintenance, alteration or suppression of regulatory obligations with respect to the markets for wholesale (physical) network infrastructure access at a fixed location and wholesale broadband access, in accordance with article 8. of Law no. 5/2004 of 10 February". See http://www.anacom.pt/streaming/rela_consulpublica_mercados4_5.pdf?contentId=759738&field=ATTACHED_FILE.

[375] http://www.anacom.pt/streaming/EC_comments_pt_2008_0850.pdf?contentId=812399&field=ATTACHED_FILE.

[376] http://www.anacom.pt/streaming/analise_mercados4_5.pdf?contentId=812401&field=ATTACHED_FILE.

c) In "areas C"[377] ICP-ANACOM does not designate any operator as having SMP, whereby the obligation of price control was immediately withdrawn after the decision's adoption and the other obligations imposed on Grupo PT were eliminated after a transitional period of twelve months;

d) In "areas NC"[378] (i.e. all other areas of the territory), ICP-ANACOM designates Grupo PT as having SMP and has maintained obligations previously imposed (in 2005) on Grupo PT and imposes additional obligations (introduction of the "*Naked DSL*" offer and amendments to the transparency obligation).

e) ICP-ANACOM refers to the possibility of including access to advanced bitstream offers, i.e., supported by optical fibre access.

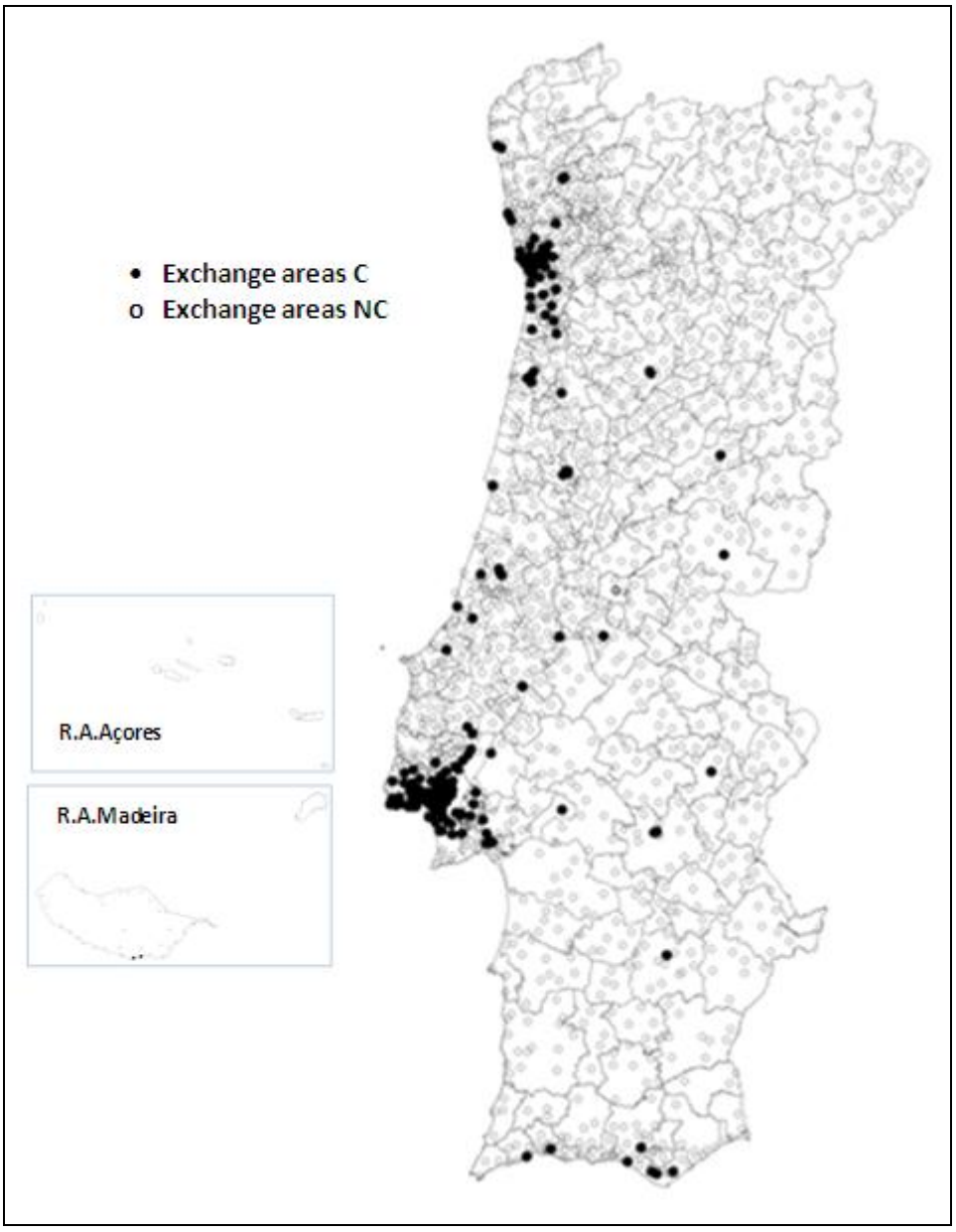
In the previously mentioned comments submitted by the EC, it is noted that, at this stage, ICP-ANACOM does not impose any obligations in relation to optical fibre[379], but that the deployment of optical fibre, already present in the national market, may significantly alter the competitive landscape, especially if MDF (local exchanges where there are or may be co-located operators) are closed. According to the EC, this aspect is particularly relevant in the Portuguese situation, where competition in the broadband retail market and Market 5 is constrained by the availability of sufficient *inputs* in Market 4 (LLU).

[377] "Areas C": areas comprising exchange areas (MDF) where there is at least one co-located operator and where there is at least one cable distribution network operator and where the percentage of homes cabled by the main operator in the exchange area exceeds 60 percent;

[378] "Areas NC" are other areas that are not "areas C".

[379] While acknowledging that there is an operational obligation of access to ducts in Portugal and that ICP-ANACOM is preparing measures in aspects related to NGA.

Figure 68 Geographical location of market 5



Source: ICP-ANACOM

In light of the above, the EC invited ICP-ANACOM to impose remedies applicable to optical fibre access products, as appropriate, after the national consultation on NGA.

In this context, in February 2009, ICP-ANACOM released a "Public Consultation on the Regulatory Approach to Next Generation Access Networks"[380], centred on development at the level of the fixed access network, given that the most part of regulated products are supported on the historic operator's fixed network, and with the aim of finding a prospective

vision for the development of NGA, particularly in terms of its scope and its impact on existing networks and products, and also on regulated wholesale access products, such as offers of access to ducts (RDAO), to the local loop (ROU) and to broadband ("*Rede ADSL PT*").

From the responses to this consultation[381], note is made of the existence of two different positions with respect to the regulation of NGA since, while the historic operator advocates a near break with prevailing regulatory logic, alternative operators seek to extend it, almost without modification, to the development of the NGA.

In this report, ICP-ANACOM included a section on transition from LLU-based business models to NGA-based models, setting out the conditions that should be fulfilled in the transition of the business models based on LLU to NGA, including:

a) Continuity of LLU-based models (while there is dominance in the respective access market) over the short term. Without this continuity operators could see expectations and past investments disappointed, inhibiting progress to NGA and competition itself (creating a risk of (re)monopolization) with the concurrent establishment of mechanisms for non-disruptive migration, notably linked to the timely publication of information on the dominant operator's evolution of NGA[382]
b) Following the principle of proportionality in the imposition of obligations, a "phased" approach is considered, potentially based on the analyses of Markets 4 and 5[383], where, in addition to obligations of non-discrimination and transparency related to the transition of LLU-based models to models based on NGA:

    b.1) In competitive areas, access is only imposed with respect to ducts, with improvements and equivalence of access, whereas other obligations are imposed (access to own fibre or dark fibre) only where there is no space in ducts. As a last resort, where there is agreement between the parties, and as an alternative to access to own fibre or dark fibre, the option of virtual access to the network may be taken;

    In non-competitive areas, in addition to access to ducts, access to own fibre or dark fibre is also imposed, as well as virtual access to the network ("advanced bitstream").

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[381] http://www.anacom.pt/streaming/relatorio_NRA_final.pdf?contentId=850938&field=ATTACHED_FILE.

[382] ICP-ANACOM may eventually decide on this matter, in the event that there is no agreement within a short period between PTC and the beneficiaries of the RUO.

[383] In Market 4 - "-Market for supply of wholesale network infrastructure access (physical), as well as in Market 5 -"Market for supply of wholesale broadband access".

ICP-ANACOM has also provided advice to the government with respect to the preparation and evaluation of tenders for the installation, management, operation and maintenance of high-speed electronic communications networks, as detailed previously.

6.2.2 Suitability of Legislation

ICP-ANACOM worked with the government in formulating the previously referenced Decree-Law no. 123 /2009, which established a rule of non-discriminatory and open access to ducts, masts and other facilities belonging to entities which, operating in other sectors, are in possession of infrastructure of significant importance.

This regime sets outs to remove or mitigate the barriers to the construction of infrastructure for the accommodation of electronic communications networks, with provision for rules which, likewise, facilitate the coordination of underground works, including with respect to the obligation to give prior notice of the execution of works which allow for the construction of infrastructure and allow other companies/operators of this sector to associate themselves with this intervention.

6.2.3 Reduction of horizontal barriers

With regard to access to ducts and associated infrastructure, ICP-ANACOM agrees with the application of the "Principle of equivalence"[384], established by the EC Recommendation on NGA,. This principle aims to prevent the historic operators (in possession of extensive passive infrastructure) from exploiting their competitive advantage, which they have from the outset, in an illegitimate way, in particular by obtaining privileged information or following procedures which are faster and distinct from those offered to competitors in access to passive infrastructure - including ducts.

ICP-ANACOM contracted the consultancy firm Oxera to conduct a study entitled *"Vertical functional separation in the electronic communications sector - What are its implications for*

[384] The "Principle of equivalence" is embodied in the following equivalent conditions:

a) Equivalence in terms of access to information: Information on the location of ducts and associated infrastructure, available space in ducts and in street cabinets, network topology, connections to and locations of street cabinets;

b) Equivalence in terms of time taken to respond and to supply: The SMP operator shall implement an information system incorporating the time taken to respond and supply to their own departments for the installation of NGA and must ensure that third party beneficiaries have access to relevant infrastructure in the same time.

c) Equivalence in terms of management of the service: The SMP operator shall ensure that requests for information, supplies and repairs made by third party beneficiaries are processed with the same speed as requests made by its own equivalent departments. Periodic reports shall be published setting out the levels resulting in practice;

d) Equivalence in terms of service levels agreements: The evaluation of times taken for delivery and response, with the respective reports sent to the beneficiary for the purpose of providing compensation for non-compliance.

the Portuguese market?"[385], published in July 2009. This study on Vertical Functional Separation (VFS) examined a diverse set of scenarios with different combinations in terms of complexity, product arrangement and equivalence requirements in terms of inputs and outputs, looking also at the different impacts on market outcomes, investment and innovation and regulatory processes.[386]

Oxera concluded, *inter alia*, that for a more comprehensive study of the conditions of equivalence between the products and services that PTC supplies to companies of the group and to its competitors, it would be very useful to have details of the KPI results (Key Performance Indicators) which PTC reports to ICP-ANACOM. This publication obligation was imposed on PTC by ICP-ANACOM determination of March 2009 on the publication of levels of QoS performance in regulated wholesale offers, LLRO, RDAO, "Rede ADSL PT" and WLRO.

On 28.11.2010, ICP-ANACOM approved the final decision on introducing amendments to the RDAO, which primarily addressed issues related to:

a) Improving the interface between alternative operators and PTC;
b) The removal of "dead" (unused) cables from ducts;
c) Greater transparency in determining technical feasibility for passing cable (in ducts);
d) Improved response times.

6.2.4 Reduction of vertical barriers

Following Decree-Law no. 123/2009, in November 2009, ICP-ANACOM gave approval to the final versions of two draft technical manuals: the ITED Manual[387] (Technical specifications and requirements with respect to telecommunications infrastructure in buildings - 2nd edition) and the ITUR Manual[388] (Technical specifications and requirements with respect to telecommunications infrastructure in housing developments, urban settlements and concentrations of buildings - 1st edition).

In the ITED Manual (section 6.1), indication is given of the requirements to be observed in formulating the collective network project of optical fibre cables, making eligible, to house the

[385] http://www.anacom.pt/streaming/final_report_oxera_jul2009.pdf?contentId=968163&field=ATTACHED_FILE.

[386] This determination follows the report on the prior hearing to with the respective draft decision, approved on 15 October 2008, was submitted. In its determination of 26 May 2006, it was determined that the PTC should send the beneficiaries of offer, on a quarterly basis, a performance report of quality, broken down per month. See (http://www.anacom.pt/streaming/deliberacao11032009.pdf?contentId=871778&field=ATTACHED_FILE.

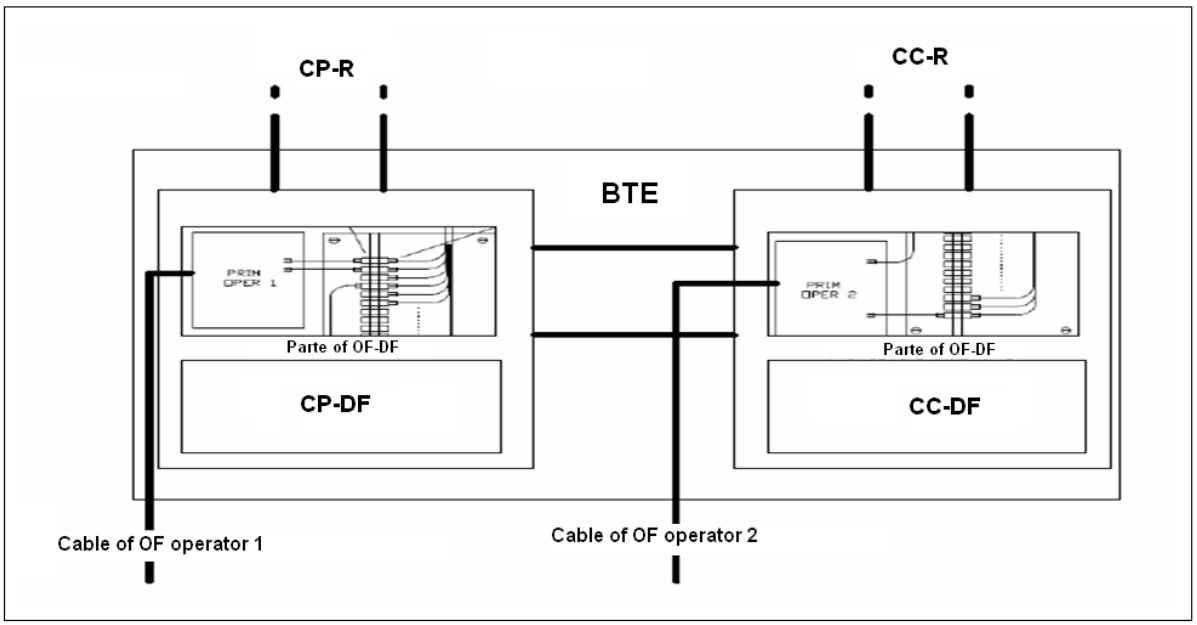
[387] http://www.anacom.pt/streaming/manual_ited_2.pdf?contentId=995812&field=ATTACHED_FILE

[388] http://www.anacom.pt/streaming/manual_ITUR1edicao_Novembro2009.pdf?contentId=995810&field=ATTACHED_FILE

main optical fibre distribution frame (OF-DF)[389], all space belonging to the collective piping network. This space should have capacity for the installation of the cabling and equipment of at least two operators, whereas the designer must make the choice of space according to a set of criteria that favours the choice of the BTC[390] and ensures access to all units (see Figure 69).

Meanwhile, paragraph 3.6.5.5 of the new ITUR Manual states that in order to ensure open and non-discriminatory access by electronic communications operators, at least two optical fibres should be installed per unit.

Figure 69 Diagram of shard assembly



Source: ICP-ANACOM, ITED Manual [391]

6.3 Operators

As at the end of the third quarter of 2010, there were some 4.8 million cabled households in Portugal with access to high-speed (optical fibre and EuroDOCSIS 3.0 or equivalent).[392] This puts Portugal in a leading position at European level in terms of the coverage rate of

[389] OF-DF: Main optical fibre distribution frame.

[390] BTC: Building Telecommunications Cabinet.

[391] BTC: Building Telecommunications Cabinet, CC-R: Coaxial Cable Riser, CP-R: Copper Pair Riser, CP-CS: Copper Pair Client Splitter, CC-DF: Main Coaxial Cable Distribution Frame, OF-DF: Main Optical Fibre Distribution Frame.

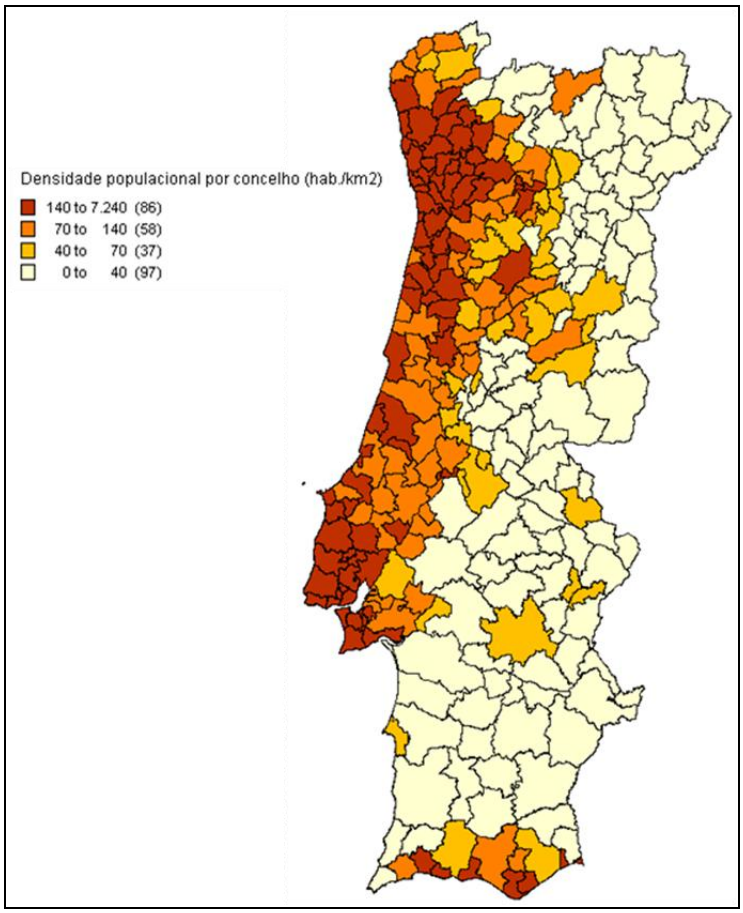
[392] The provision of the service by more than one operator in the same area implies the possibility of multiple cabling of the same household. This means that the sum of cabled households by all operators may result in duplicate counting. It is estimated that the effect of double counting reaches, at most, 27.9% in the case of FTTH/B, 14.6% in the case of EuroDOCSIS 3.0 and 37.7%, if FTTH/B and EuroDOCSIS 3.0 are considered together.

households. Of the cabled households, about 30% were cabled with optical fibre accesses and 70% were cabled with accesses using EuroDOCSIS 3.0 or equivalent.

As well as some other entities, 17 operators are already well advanced in the deployment of NGA in Portugal, giving priority to urban areas with high population density. Of these operators, note is made of PTC (FTTH) and ZON (DOCSIS3.0), operators with the largest number of customers supported over high-speed access, followed by Cabovisao and Sonaecom. PTC and ZON dominate in terms of FTTH and Eurodocsis3.0 or equivalent, respectively, in terms of market share of cabled households.

Municipalities with greater deployment of NGA are roughly those located along the coast and are the most densely populated (*see* **Figure 70**).

Figure 70: Population density per municipality



Source: ICP-ANACOM, based on data from INE (Statistics Portugal), 2008

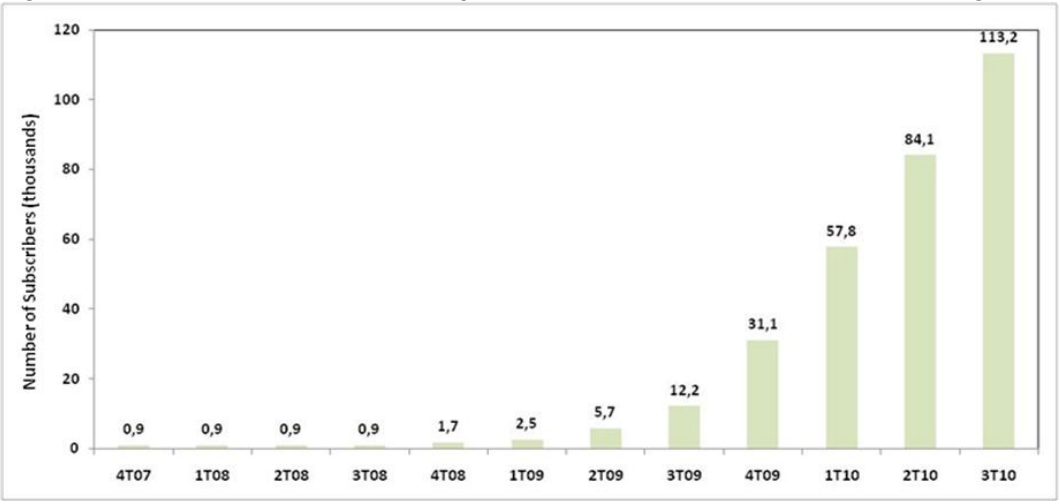
In terms of total number of households cabled by high-speed networks by NUTSII, the Lisbon region is best placed, followed by the North and A.R. Madeira. At the end of the third quarter of 2010, the sum of cabled households for all operators stood at 4.8 million. This

increase reflects the expansion of Grupo ZON/TV Cabo, especially in the North and Centre, and of Cabovisão in the Setúbal Peninsula.

In the third quarter of 2010, there were around 237 thousand customers supported over high-speed accesses, 95% of which were residential customers.

The number of subscribers to subscription television using FTTH technology has evolved as shown in Figure 71, with a sharp rise seen between late 2008 and the third quarter of 2010.

Figure 71 Subscribers to the subscription television distribution service using FTTH



Source: ICP-ANACOM

Subject to more detailed presentation (which will be done subsequently) of the characteristics of the offers to residential customers of operators with the largest volume of NGA passed homes, the following features are highlighted:

a) In general, the provision of these services is associated with bundled offers, combining Internet access, the fixed telephone service and television channels;
b) There is a diverse range of speeds available to the customer between a minimum of 10 Mbps (in one of PTC's offers) and 1 Gbps (one of ZON's offers);
c) The monthly prices of the offers generally range from between about 40 euros (for downstream speeds between 10 Mbps and 30 Mbps) and 100 euros (for downstream speeds of 200 Mbps), though in the case of ZON, the price of the offer with the highest speed (1 Gbps) amounts to around 257 euros per month.

6.3.1 PTC

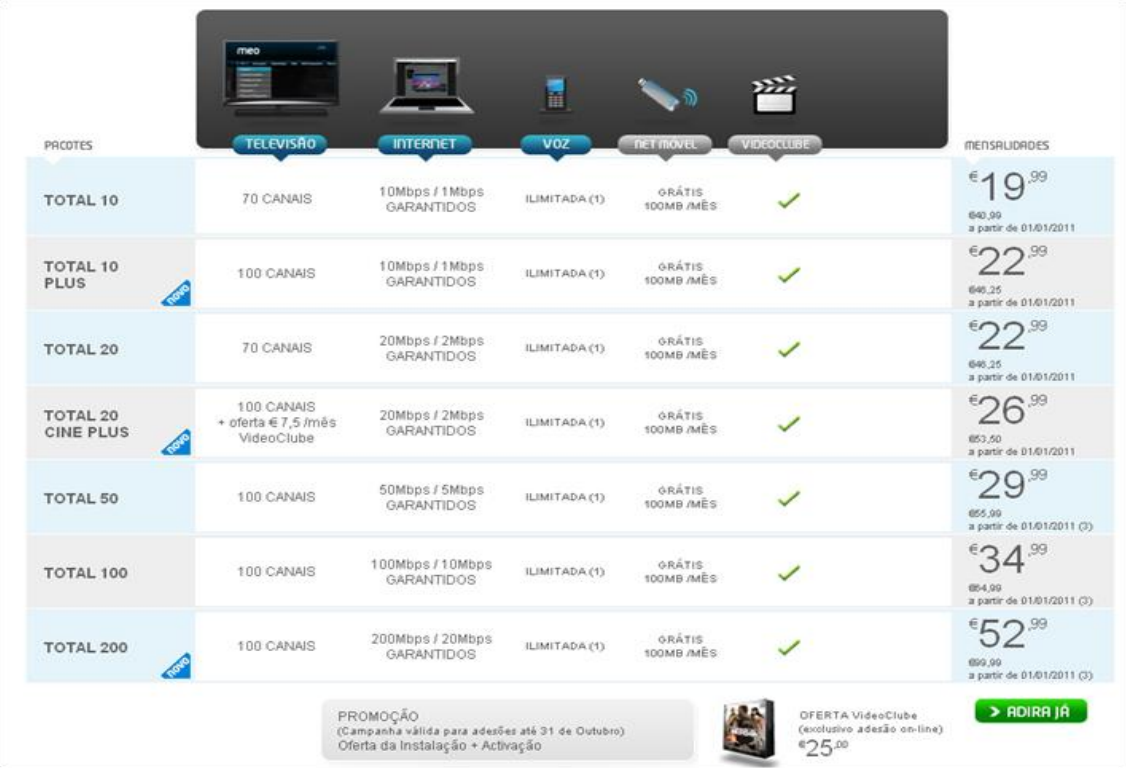
In electronic communications markets, PTC itself has considered crucial its "triple play" bundle offers supported over NGA, where it faces stiff competition, particularly from ZON. As such, the incentives for PTC to invest appear to be strong, especially considering the offers

of high-speed Internet access offered by its competitors and the regulatory principles already established by ICP-ANACOM.

Currently, PTC has more than 1 million homes passed with FTTH, supported on a network of 480 thousand km of optical fibre, and the operator intends to invest in another 600 thousand passed homes[393].

The offer conditions of the historic operator's different *"triple play"* bundles using fibre, are summarized in Figure 72. PTC's packages include television (70 to 100 channels), FTS (with unlimited calls to fixed network 24 hours a day), Internet access (with downstream speeds between 10 Mbps and 200 Mbps) and free mobile broadband (with a monthly limit of 100 MB). Prices range from about 40 euros to 100 euros per month, although there are currently offers where these prices are reduced by half for a limited period of time.

Figure 72 PTC High-speed Bundles (MEO)



Source: PTC

PTC's strategy is essentially based on three pillars: building a high-quality network with nationwide coverage, effectively managing the network based on technologically updated solutions and offering innovative solutions to fully exploit the potential of FTTH[394].

[393]http://www.telecom.pt/InternetResource/PTSite/PT/Canais/Investidores/infofinanceira/reltrim/restrim.htm.

Under the operational focus, the deployment of the optical fibre access network will take place over a period of about five months and can be divided into five stages, namely[395]:

a) The selection of areas, based on their market potential, market consistency and hierarchy;
b) The project, in which the network is designed according to predefined rules;
c) The construction of the external network;
d) Quality control and certification;
e) Availability for sale.

According to PTC, with respect to fibre, the company does not want to compete on price but on quality and user experience. In this context, the choice of FTTH-GPON (looking ahead to an evolution in the medium term to WDM-PON) allows a minimum speed of 100 Mbps, with a network that reaches directly to the customer's home. It also allows, in comparison to an point-to-point Ethernet architecture, a reduction in capital expenditure of between 30% to 60% and a quite significant reduction in energy costs, in addition to an occupation of space which is seven times lower.

According to the historic operator, the service's installation is performed quickly and less intrusively, taking advantage of already installed coaxial cable[396]. Furthermore, the learning curve of this service provider has resulted in a reduction in average customer installation time with respect to works performed ″in house″ (e.g. from 4:46 linear hours at the end of 28 weeks to 4:20 linear hours to the end of 38 weeks) and also the average total time of installation (which, for MEO fibre decreased from 11.94 linear days after the first month to 10.37 linear days after the sixth month)[397].

It also requires the installation of an ONT (optical termination equipment), which, in a first phase, are provided by a set of three manufacturers. PTC also currently associates fibre with RF Overlay, avoiding the need for a "set-top-box" for each television set, simplifying installation in the customer's home and reducing associated costs.

Following this investment announcement, PTC entered into a partnership with a world-leading manufacturer of optical fibre and with an equipment manufacturer, with the aim of

[394] According to information released by PTC at the 2010 Lisbon FTTH Conference, in the presentation, "FTTH - The Service and Application Enabler".

[395] According to information released by PTC at the F.O. Networks Seminar of ACIST 2010, presentation "PT, a company with fibre".

[396] According to information released by PTC at the 2010 Lisbon FTTH Conference in the presentation,"FTTH - The Service and Application Enabler."

[397] According to information released by PTC at the F.O. Networks Seminar of ACIST 2010, presentation "PT, a company with fibre".

"Developing value-added solutions for the residential and business market segments", enabling it to "maintain a competitive advantage" in these segments.

According to press reports, on 08.08.2009, PTC will have announced its intention to provide speeds of 1 Gbps in residential optical fibre accesses in 2010 and plans to launch services with bandwidths to the order of 10 Gbps in 2011 or 2012. Taking into account that optical fibre terminal equipment (ONT 10 Gbps) is currently being developed by the University of Aveiro, Instituto de Telecomunicações (Telecommunications Institute) and by PT Inovação, which will allow internet access with speeds of up to 10 Gbps, also saving around 20% on energy consumption compared to other devices on the market.

It is noted that on 18.09.2009, PTC received formal approval from the European Investment Bank (EIB) for a long term loan worth 200 million euros (with the total investment still to be estimated) in order to expand its NGN/NGA infrastructure, providing their customers with a high-speed broadband service[398].

Regarding the conditions of wholesale offers to be provided to its competitors, PTC did not show recognition of the demand requirements for an active NGA access (fibre bitstream) nor does it have plans for developments in this area.

On 04.03.2010, in the presentation of its 2009 results, PTC announced[399] an increase in fixed network investment expenditure from 403 million in 2008 to 565 million in 2009, mainly as a result of FTTH network deployment and investment in IPTV, particularly related to the growth of its customer base. PTC's fixed network investment costs fell 10.9% in the first three quarters of 2010 compared to same period of 2009, which, according to the company, is due to a slowdown in efforts in FTTH deployment, but are mainly due to the decrease in investments in the historic network and in the backbone of information systems and information technology infrastructure.

6.3.2 Sonaecom

In February 2008, Sonaecom announced a plan for the implementation of optical fibre solutions with a three-year time horizon, entailing a total investment of 240 million euros for one million passed homes, with 152 million euros corresponding to investment in infrastructure and the remaining part to commercial costs and pitching to households.

[398] It is note that the amount financed, in line with loans granted to ZON and Sonaecom for the same purpose, is governed by the previously mentioned protocol made between governments and various providers of electronic communications services.

[399] http://web3.cmvm.pt/sdi2004/emitentes/docs/FR27208.pdf.

After a phase of pilot tests conducted in 2007, in September 2008, Sonaecom began supplying optical fibre ("Clix Fibra") in three areas of Lisbon (Parque das Nações, Alta de Lisboa and Benfica) and two areas of Porto (Carvalhido and Leca da Palmeira).

Sonaecom offers *"triple play"* bundles, including television (between 30 and 10FTS (with different pricing options) and Internet access (with downstream speeds between 30 Mbps and 100 Mbps), with monthly prices varying between about 40 euros and 65 euros - see Figure 73. There are also discounts for a limited period of time, between 10 euros and 25 euros and the offer of a popcorn machine upon subscription.

Currently, in accordance with the commercial offer, this operator also broadcasts analogue TV in RF Overlay, thereby enabling customers to have a set of television channels on all television sets.

Figure 73 Sonaecom High-speed Bundles

Source: Sonaecom

According to Sonaecom, customers have expressed an overwhelmingly positive reaction to the progressive installation of the FTTH-GPON network. This has also been visible in contacts between the sales teams and customers in areas covered by this network, made with a view to demonstrating the features and benefits of services supported over optical fibre.

Likewise, according to this operator, the FTTH experience has been particularly relevant because, for the first time, it enabled the operator to take full responsibility for the network used in the delivery of end-to-end services in the residential market, enabling better preparation for subsequent deployment phases.

As such, at the end of 2009, Sonaecom reached approximately 200 thousand households passed with fibre, a result of acquiring new customers and also the migration of former LLU-supported customers. This despite, according to reports published in the press, Sonaecom reducing the pace of fibre coverage in the last months of 2009, due to a requirement to limit investment in order to increase cash flow.

At the same time, this operator has been studying the establishment of partnerships with other operators, local and municipal authorities and other interested entities, as a possible alternative to expanding the optical fibre network.

In this context, on 16.09.2009, Sonaecom established a partnership with DSTelecom, whereby Sonaecom will not build new infrastructure in areas where DSTelecom already has networks.

As early as 21.12.2009, Sonaecom and Vodafone signed an agreement to ensure mutual cooperation in the area of sharing, construction, management, maintenance and operation of an NGN fibre network in major urban centres.

On 17.12.2010, both these operators reported formalizing the agreement to share NGN infrastructure in Lisbon and Porto, admitting the possibility of opening the deal to other interested operators.

To finance the investment both in its own NGN infrastructure and in infrastructure shared with Vodafone, in March 2010 Sonaecom received approval of an EIB loan worth 75 million euros.

In early 2010, the company announced a repositioning of its brand in the electronic communications services, where it will operate only with the Optimus brand for TV, Internet and for fixed and mobile telephony services. In January 2010, in a statement[400] made to the *Comissão do Mercado de Valores Mobiliários* (Securities Market Commission), Sonaecom clarified that it will invest 500 million euros in its electronic communications network over the next four years (until 2013). This is without prejudice to a strategy of investment in fibre which the company considers "capital *light*".

6.3.3 ZON

ZON's HFC network is able to offer downstream speeds of between 50 Mbps and 200 Mbps (supported over EuroDOCSIS 3.0 and progressive cell division) in approximately 90% of its

[400] http://web3.cmvm.pt/sdi2004/emitentes/docs/FR26708.pdf

network, which (according to information released by that operator with reference to the third quarter of 2010) corresponds to about 2.8 million households[401], with upgrades planned to the maximum extent of this technology over the next three to four years.

The investment made in upgrading the network in 2009 amounted to about 88.5 million euros, mainly explained by the implementation of Eurodocsios 3.0 and cell division, with the addition of 102.6 million euros invested in terminal equipment (especially set-top-boxes). In the first three quarters of 2010, ZON's total investment increased by 17.7% compared to the corresponding period in 2009, even while recurring investment has tended to decline, given the completion of EuroDOCSIS 3.0 deployment.

According to ZON, a key driver of its position in broadband has been the launch of "triple play" bundles, Including speeds of 30 Mbps, 50 Mbps, 100 Mbps, 200 Mbps and, more recently, 1 Gbps, in addition to 114 television channels and unlimited calls to the FTS, with prices ranging from around 44 euros to 257 euros (see Figure 74) (notwithstanding that, for a limited period of time, there may be discounts of up to 50%). It is noted that one month after its launch, the "triple play" bundles with the speeds mentioned already accounted for 22% of "triple play" bundles sold, and late in the third quarter of 2010, bundles of this type represented 52% of total customers with ZON bundles.

[401] http://www.zon.pt/microsites/investidores/presentations.aspx

Figure 74 ZON High-Speed Bundles

Source: ZON

It is noted that on ZON's website on such offers, it is stated that "Next Generation Internet" reaches the customer's home / area of residence using optical fibre and EuroDOCSIS 3.0, whereas there is no specific information on the link between each of the detailed offers and given a technology platform. Nevertheless, according to information released by ZON in the consolidated results for the first three quarters of 2010, about 113 thousand customers

corresponded to the "ZON Fibra" product and about 207 thousand customers benefited from downstream speeds exceeding 20 Mbps. It should be noted that a significant proportion of optical fibre customers result from the merger of TVTEL into Grupo ZON, concluded in late 2008.

It is also noted that on 28.08.2009, the operator received formal approval from the EIB for a long term loan worth 100 million euros to expand its NGA optic fibre infrastructure (with total investment currently estimated at 307 million euros), in order to provide its customers with an advanced broadband service. It should be taken into account that investment in NGA complements investment made in the "core" network, where, on 17.08.2009, the operator concluded the installation of an optical fibre infrastructure in redundant rings in the metropolitan areas of Lisbon and Porto, connecting strategic locations, such as data centres, "headends", content providers and networks of other operators. Currently ZON's network already comprises 14 thousand km of optical fibre.

In February 2010, ZON selected Alcatel-Lucent to deploy an FTTH network with GPON architecture. The contract includes the supply of around 7,300 "Intelligent Services Access Manager Fibre-to-the-User ISAM FTTU" smart centres, enabling ZON to improve quality and coverage its current offer of TV, VOD and VoIP services, and also increase its market share.[402]

In March 2010, ZON presented a demonstration television channel in three dimensions, available to all customers who have a high definition set-top-box.[403]

6.3.4 CABOVISÃO

After conducting EuroDOCSIS 3.0 tests, in July 2009, Cabovisão launched[404] a new Internet access service ("Nitro")[405], encompassed (along with TV digital and FTS service) in *"triple play"* offers, with downstream speeds of 60 Mbps and 120 Mbps. After a promotional period of twelve months (at a price of 60 euros), the price of these offers ranges between about 65 euros and 72 euros, and there is a "loyalty" period of 24 months in the case of the service with downstream speeds of 120 Mbps and 12 months in the case of the service with

[402] The "Business Monitor International -BMI" estimates that the number of ZON Internet subscribers was about 1.72 million and predicts that this number will increase by 15.5% in 2013 (1.99 million Internet subscribers.) Penetration over this period of time, will grow from the current 16% to 19%. See http://www.businessmonitor.com/cgi-bin/request.pl?view=articleviewer&SessionID=15004253803880&article=330708&service=1.

[403] To view this channel, the consumer needs a television suitable for this technology, with prices reaching 9,000 euros.

[404] http://tek.sapo.pt/noticias/telecomunicacoes/cabovisao_estreia_nitro_1005515.html.

[405] http://www.cabovisao.pt/nitro/nitro.html.

downstream speeds of 60 Mbps. In 2010 the service is present in dozens of municipalities, with most of these having EuroDOCSIS 3.0. available

Among the first areas with this service available were Viseu, Beja, Moita, Alcochete, Sesimbra and Palmela. Taking into account that although Cabovisão (such as, for example, ZON) does not have national coverage, its Chairman minimised this issue (as reported in the press on 28.05.2009) arguing that this operator has a network with 13 thousand km of optical fibre, with *"a level of coverage which is already of substantial interest"*, serving municipal councils, parish councils, universities and companies around the country.

6.4 Community networks

Community networks (supported by public funds) are open, public broadband networks, developed in disadvantaged areas or where there are market failures in the provision of electronic communications services.

In general, they link the headquarters of the councils covered, public buildings and buildings of public interest, higher education institutions, technology centres, industrial parks and zones, seeking to drive economic and social development in the community. In fact, the main objectives of this type of project for a given region are to combat info-exclusion, to promote equality of opportunity and public access to broadband, to correct imbalances in communications accessibility and develop technology-based and scientific entrepreneurship.

Such networks can facilitate the return on existing infrastructure of municipal companies (e.g. in the area of water) and complement communications infrastructure constituted in connection with Digital Cities and Regions projects.[406]

Community networks commonly have the following characteristics:

a) They are networks of public interest;
b) The serve a local community;

[406] Another important network, formed several years ago, is the RCTS - Rede de Ciência e Educação (Science and Education Network); this is a computer network linking scientific research and education institutions, also providing a link to the international research and education network, and is operated by FCCN - Fundação para a Computação Científica Nacional (Foundation for National Scientific Computing), a non-profit association whose activities are mainly financed by UMIC-Agência para a Sociedade do Conhecimento, IP (Knowledge Society Agency) and that are associated with FCT - Fundação para a Ciência e a Tecnologia, IP (Foundation for Science and Technology), UMIC - Agência para a Sociedade do Conhecimento, IP (Knowledge Society Agency), CRUP - Conselho de Reitores das Universidades Portuguesas (Council of Portuguese University Recotrs) and LNEC - Laboratório Nacional de Engenharia Civil, IP (National Laboratory for Civil Engineering). See http://www.umic.pt/index.php?option=com_content&task=view&id=29&Itemid=187.

c) All traffic that begins and ends within the network should tend towards no charge;
d) They have technological neutrality and independence;
e) Are open to access and use by any operator or provider of electronic communications services wishing to serve the community;
f) They are not owned by an operator or provider of electronic communications services in the traditional sense;
g) They are controlled independently of any supported service or content.

The network designs have to be neutral in relation to competing technological solutions, and demonstrate economic sustainability and provide equal access to all operators interested in their use.[407]

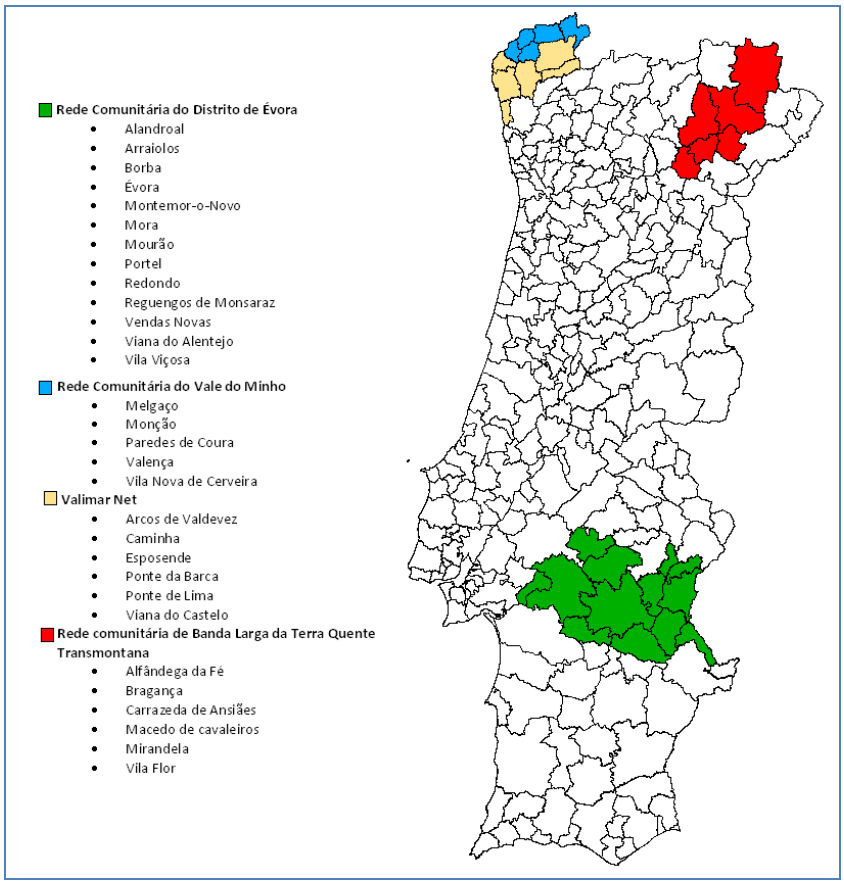
Between February and April 2006, the POSC - Programa Operacional da Sociedade do Conhecimento (Knowledge Society Operational Programme) opened a public tender for community network projects, whose promoters had to be public entities, which should provide for 55% of total costs[408.] In April 2007, four Community Networks projects were approved[409], at a total of 34 million euros (see Figure 75) comprising the regions of Evora, Tras-os-Montes and Minho.

[407] The licensed operators of electronic communications are the only entities which can provide services to private end-customers.

[408] UMIC constituted and operated the Technical Support Commission provided for in the regulation of the corresponding measure of POSC to support tenderers in the development of the application process and to monitor deployment of approved projects.

[409] http://www.umic.pt/index.php?option=com_content&task=view&id=28&Itemid=187. evora. http://www.umic.pt/index.php?option=com_content&task=view&id=29&Itemid=187.

Figure 75 Location Map of Community Network projects



Source: UMIC (2009)

In conjunction, these projects result in networks which are comprised of more than one thousand kilometres of optical fibre cable, allowing connections and services in very wide broadband supported over optical fibre, in particular between 1 Gbps and 10 Gbps.

These four network projects were almost concluded by the end of 2008, with a length of roughly 1200 kilometres of optical fibre.

Infrastructure tests were conducted on these four networks at the beginning of 2009, followed by the process of bringing fibre first to the network of partners making up each consortium (entities related to local authorities, universities, etc.) and then to businesses and the region's population. This last phase of operation and development of services is promoted by the municipal associations. These networks will work according to a multi-operator system, selected through the launch of operating tenders[410], in the mode that allows multiple operators to use the infrastructure. The operation phase is expected to begin by the end of 2009

[410] See http://www.vector21.com/cp/?id_categoria=19&id_item=40766.

The Valimar Net and Vale do Minho Community Networks, which have the networks interconnected through two rings, have chosen to develop inter-municipal companies through PPP, whose business is the construction, maintenance and operation[411] of optical fibre community networks for sale to operators. In both cases DSTelecom was the main private partner.

In addition to the four projects which are detailed in the following sections, there is also the NetDouro project, which started in 2004, resulting from a partnership between the company AdDP[412] (Águas do Douro e Paiva, SA - extracts and distributes water), and its shareholders and customers, with the mission of creating value in the use of the installed optical fibre network and the aim of exploiting AdDP's own communications infrastructure. In this sense the company NetDouro was founded[413], with this network interconnecting the associated municipalities and allowing the sharing and reduction of electronic communication costs.

This project combines the primary purpose which determined the construction of the AdDP's infrastructure (water supply management system) with the development of projects that can make an important contribution to regional development and, ultimately, improved quality of life of the populations.

It took advantage of the capacity of the communications network installed practically at marginal cost at the time of installation of ducts (coverage of system structures with an optical fibre network had the essential goal of providing the tele-management/telemetry system in AdDP's water distribution), exceeding the needs of AdDP's business, providing a part of this infrastructure, setting up a regional infrastructure, with characteristics of broadband intranet with extremely low access and usage costs, providing a voice, data and image network.

The connection to Vale do Sousa Digital is already functioning and the connection to Maia and Porto Digital made through the respective municipalities. Additionally, connections to further municipalities are envisaged, including Amarante, Resende and Marco de Canavezes. Today NetDouro has an optical fibre network with approximately 400 km of

[411] The Valimar Net and Vale do Minho Community Networks are based on a procedure that enables, in the same tender, a private partner to be found to form a joint venture, which partner is not only responsible for building the infrastructure, in future will also be responsible for its management and operation, whereby construction, management and operation falls to the same entity.

[412] Águas do Douro e Paiva, S.A. - company of private law and public capital owned 51% by Águas de Portugal and 49% by a group of 18 municipalities (Arouca, Castelo de Paiva, Cinfães, Espinho, Felgueiras, Gondomar, Lousada, Maia, Matosinhos, Oliveira de Azeméis, Ovar, Paços de Ferreira, Paredes, Porto, Santa Maria da Feira, São João da Madeira, Valongo, Vila Nova de Gaia). Águas do Douro e Paiva is concessionaire of the multi-municipal system surrounding the city of Porto until 2026.

[413] NetDouro - Gestão de Infra-estruturas de Telecomunicações, SA, was founded in May 2004 and endowed with a capital of one million euros, as a subsidiary of AdDP.

ducts and optical fibre cables, present in eighteen municipalities of Greater Porto and Vale do Sousa, with a population of about 1.7 million inhabitants.[414]

6.4.1 "Terra Quente" Broadband of Trás-os-Montes

This project, with a fibre infrastructure of 235 km in length (including 75 km of ducts) is promoted by Associação de Municípios da Terra Quente Transmontana (Association of Municipalities of the "Terra Quente" area in Trás-os-Montes) and involves six municipalities (Alfândega da Fé, Bragança, Carrazeda de Ansiães, Macedo de Cavaleiros, Mirandela, Vila Flor).

The project envisages coordination with inter-municipal planning projects for culture, leisure and telemedicine, as well as the IT integration of various Santas Casas da Misericórdia (Holy House of Mercy), the telemanagement of various public urban and forest CCTV networks, articulation with the "*Fun Zone Village* Douro" project[415] and facilitation of connectivity with the RCTS[416] which serves the higher education and research institutions in the area covered. The promoter is responsible for developing and laying the entire project, with technical aid provided by Instituto Politécnico de Bragança.

The "Terra Quente" Broadband Network of Trás-os-Montes will have an investment of 7.7 million euros, with 3.5 million euros reimbursed by EU funds. The remaining 4.2 million are distributed among the five municipalities of Terra Quente. It is expected that 90 thousand people will be able to access this NGN.

The "Terra Quente" Community Network of Trás-os-Montes was authorized by the government in March 2009 to borrow 1.8 million for the project's development.

6.4.2 District of Évora

The Community Network project of the District of Évora (see Figure 76) was promoted by AMDE - Associação de Municípios do Distrito de Évora (Association of Municipalities of the District of Évora), involving fourteen municipalities (Alandroal, Arraiolos, Borba, Estremoz, Évora, Montemor-o-Novo, Mora, Mourão, Portel, Redondo, Reguengos de Monsaraz,

[414] http://www.addp.pt/pt/noticia.php?ref=522 and http://www.dstsgps.com/content.asp?startAt=2&categoryID=579&newsID=2236 .

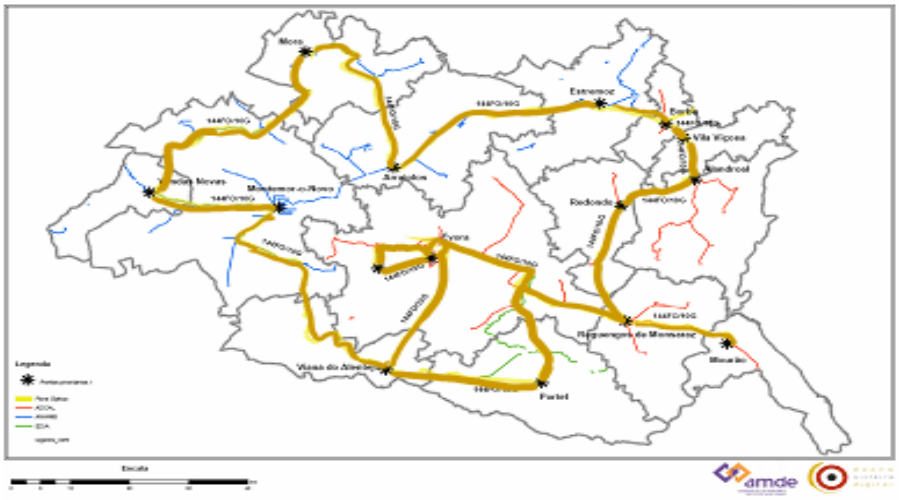
[415] Fun Zone Village Douro was presented publicly in May 2006, with its location planned for Alfândega da Fé. This is an "innovative" tourism project to be deployed in an area of one hundred hectares, creating eight hundred beds. The initiative involved an investment of 250 million euros, which would have a large impact on the local and regional economy by directly and indirectly generating hundreds of jobs, with additional associated projects, including the transformation of the airfield in Mirandela into a regional airport with capacity to receive international flights, and a container factory, in Macedo de Cavaleiros.

[416] - Rede Ciência Tecnologia e Sociedade (Technology and Society Network)

Vendas Novas, Viana do Alentejo, Vila Viçosa), launched with the signing of the respective construction contracts, occurring on 08.05.2008.

This project should coordinate with inter-municipal planning projects for culture, leisure and the knowledge triangle (education, research and innovation), extending industrial estates and areas, agricultural, agro-industrial and tourism projects for the Évora distinct with the Évora Digital District project and the BDIG - Base de Dados de Informação Geográfica (Geographic Information Database) project and it envisages connectivity with the RCTS network, which serves the higher education and research institutions of the area covered.

Figure 76 Map of locations of Community Network of the District of Évora



Source: UMIC (2009)

The project envisages a main optical fibre ring of 452 km, with aerial routing and with a 26 km connection to the University of Evora in underground routing, totalling about 480 km. The associated investment totals around seven million euros.

The process of choosing a managing entity for the network took place simultaneously with the tender which chose the partner entity to pass the fibre through the ducts.

The tender launched for the "Design and Construction of the Community Broadband Network of the District of Évora" was awarded to the consortium led by PT PRIME, NEXTIRAONE and ENSULMECI.[417]

6.4.3 Vale do Minho

This project (see Figure 77) was promoted by the Comunidade Intermunicipal do Vale do Minho (Vale do Minho Intermunicipal Community) and covers 5 municipalities (Melgaço, Monção, Paredes de Coura, Valença and Vila Nova de Cerveira). It should link up with the

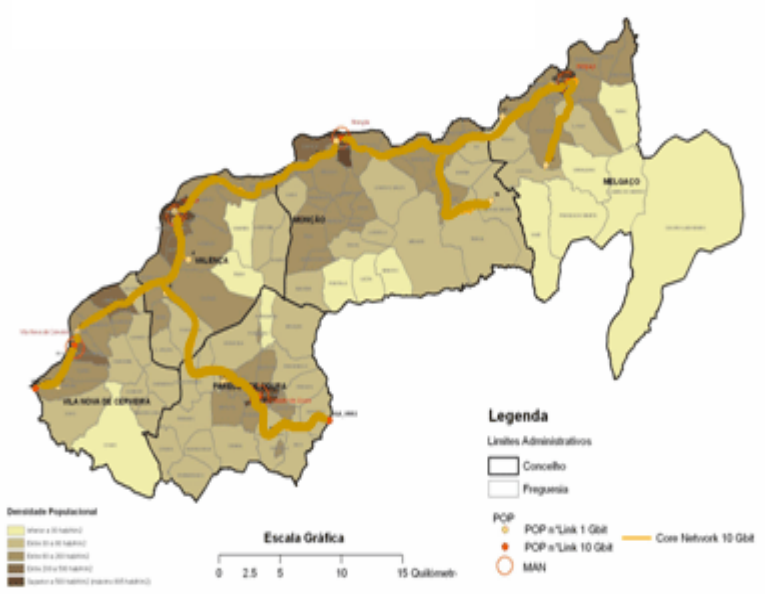
[417] http://www.adral.pt/index.php?option=com_content&task=view&id=285&Itemid=2&lang=pt.

Vale do Minho Digital project and the wind farm network, the Valença Logistic Platform and the Business Parks Network.

The promoter is responsible for the development and deployment of the service, with technical assistance provided by Instituto Politécnico de Viana do Castelo.

The project provides an optical fibre infrastructure extending over 135 km and the total project cost is estimated at 9 million euros. To implement a network with an investment of this size, an inter-municipal company was set up called MinhoCom[418].

Figure 77 Map Showing Location of Community Network of Vale do Minho



Source: UMIC (2009)

6.4.4 Valimar Net

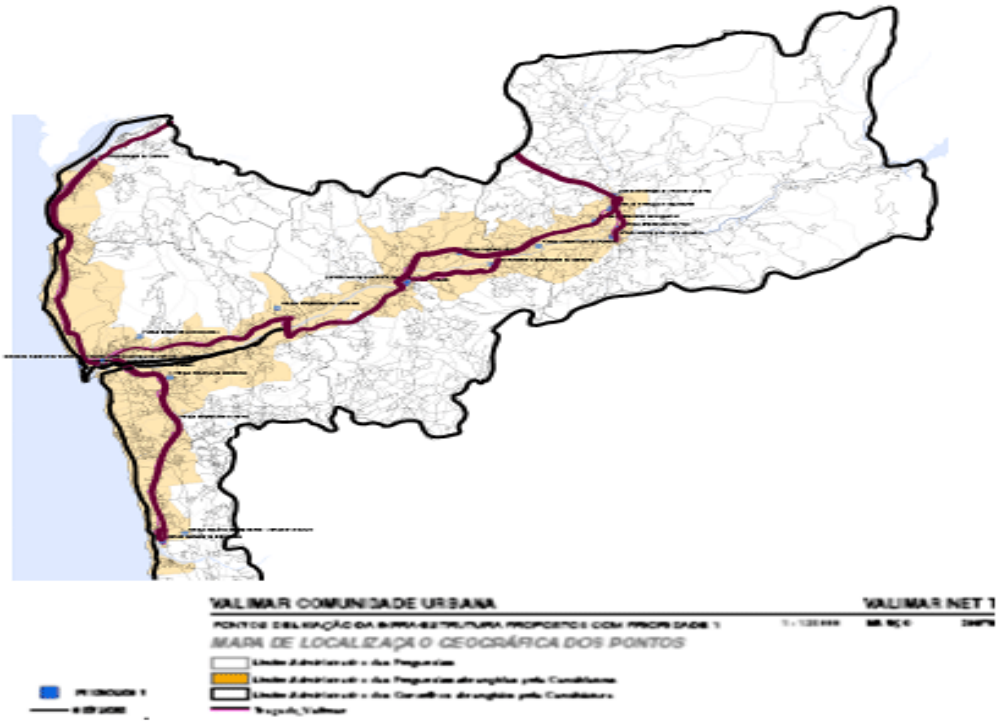
This project, budgeted at about ten million euros, is promoted by VALIMAR ComUrb - Vale-e-Mar Comunidade Urbana (Vale-e-Mar Urban Community) and involves six municipalities (Arcos de Valdevez, Caminha, Esposende, Ponte da Barca, Ponte de Lima and Viana do Castelo). Coordination is envisaged with the Infrastructure Development and Expansion Plan (Optical Fibre Ring of Viana do Castelo), Parquemp - Network of Business Parks, with the Valimar Digital project, Padre Himalaia Knowledge Park, Renewable Energy Projects

[418] The Vale do Minho Intermunicipal Community (predecessor of Vale do Minho-AM) in partnership with DSTelecom and CellCraft, International Ltd., formed an inter-municipal company called MinhoCom - Gestão de Infraestruturas de telecomunicações, E.I.M. This company's main activity is the construction and operation of the Community Network of Vale do Minho, in a regime of public service. The Association of Municipalities of Vale do Minho holds 51% of the company's social capital with the remaining 49% subscribed by the project's private partners. See http://www.valedominho.pt/portal/page/valedominho/ValedoMinho/Parcerias/MINHOCOM.

(biomass and wind), Virtual Campus of the Polytechnic Institute of Viana do Castelo. The promoter is responsible for the development and deployment of the service, with technical assistance provided by Instituto Politécnico de Viana do Castelo.

The project (see Figure 78) envisages an infrastructure of optical fibre extending 240 km and, in line with the Community Network of Vale do Minho, it was decided to create an inter-municipal company, Valicom.[419]

Figure 78 Map Showing Location of Community Network of Valimar Net



Source: UMIC (2009)

6.5 Social impact of NGN

Investment in NGN should have a quite significant social and economic impact, particularly in Portugal, in terms of sectors such as health and social work, mobility, logistics, security and justice.

Worldwide, with inevitable repercussions on the Portuguese economy and society, it is likely that the new range of possibilities offered by NGN will contribute to (Cave et al, 2009):

[419] This is a municipal company brings together the six municipalities of Valimar, with the goal of building and managing this network. The company's share capital is 50 thousand euros, 51% held by Valimar ComUrb, 48.5% by DSTelecom and 0.5% by CellCraft International. See http://www.radiogeice.com/site_radio/index.php?option=com_content&task=view&id=4963&Itemid=1 and http://www.computerworld.com.pt/content/view/6508/52/.

a) The development of communications infrastructure accessible using a diverse range of equipment and technologies (which will tend to increase, *ceteris paribus*, the perspectives of info-exclusion);
b) The evolution of computing as a ubiquitous *"utility"*, reducing the digital barriers related to differences in access to computers;
c) The "intelligence" of networks, leveraging other technologies such as nanotechnology, cognitive computing, cybernetics, RFID and virtual environments;
d) The emergence of an Intelligent Web.

However, at present, it is difficult to quantify this impact, particularly in terms of financial data from operators, in light not only of the limitations of available information, but also and mainly due to uncertainty about the evolution of macroeconomic variables in the national and world economy and due to the rapid development of the technology and the needs of end-users. It is noted that a robust quantitative approach would only be possible in any way through extremely complex general equilibrium models and that the result would still be doubtful given the current economic conjecture.

Nevertheless, it is expected that NGN will contribute to the creation of a significant number of skilled jobs in Portugal, in addition to temporary jobs associated with the infrastructure deployment phase.

For Germany, coverage is envisaged with a network with speeds of at least 100 Mbps, 50% of households in the short term and 30% of households by 2020, generating 541 thousand direct jobs in the industries of construction and electronics, whereas the number of indirect jobs, due to innovative services, could reach 427 thousand. The annual impact on GDP for the period between 2010 and 2020 will be approximately 0.6% of GDP.

Other identified benefits related to the spread of broadband (which are expected to remain valid in the context of high-speed broadband associated with NGN) involves the fact that it keeps people (both unemployed and people looking for another job) interested in the job market.

According to Beard et al (2010), people with access to broadband Internet show a greater interest in staying connected to the labour market in more than 50% of cases when compared with people without Internet access.

It is also true that due to higher bandwidth, faster transmission and greater network resilience, NGN facilitates the adoption of telecommuting, encouraging greater productivity and a reduction in associated transportation times and energy consumption (RAV, 2010).

In addition, important results are expected in terms of reducing energy consumption and the consequent reduction in carbon emissions, resulting from the widespread adoption of NGN and from its overall impact on lifestyles and working conditions, besides actual teleworking.

According to estimates released by the ITU (2008), the reduction in CO_2 may amount to: (a) 460 Mt worldwide by 2020 and (b) 330 kg per user in Europe over a period of 15 years. In a study (Ovum, 2009), it is even reported that in the case of Sweden, where fibre was deployed across the whole country energy saving were possible amounting to the equivalent of the production of a nuclear power station.

In Portugal, PTC expects that after full deployment of its FTTH network, it will be possible to reduce power consumption to less than half current levels.[420]

[420] As disclosed publicly by PTC at the Lisbon 2010 FTTH Conference, in the presentation "FTTH - The Service and Application Enabler".

7 Conclusion

There is a widespread belief in Portugal, as elsewhere, that investment in NGA has a very significant social and economic impact, especially in sectors such as education, health, social work, mobility, logistics, justice, security and energy (with particular attention to a reduction in carbon emissions resulting from energy efficiency gains in networks and equipment).

The evolution of access networks (driven by the demand side with the exponential growth of Internet traffic) has been observed in HFC networks, in networks consisting entirely of optical fibre and soon also in LTE mobile networks. As such, it is important to follow the rapid change and understand the details of the technology and architectures supporting the deployment of these networks, with the aim of analyzing their cost-effectiveness and the feasibility of any different investment sharing solutions with respect to network access - when and if deemed appropriate and proportionate in regulatory terms in light of the promotion of sustained competition.

At an international level, the development of high-speed networks will be the result of a combination of competitive strategies adopted by leading operators and the role played by the intervention of the NRA and the State.

The role of the state is essentially sub-divided into two components:

a) In ensuring transparent legislation that promotes investment in NGA throughout the national territory, while at the same time safeguarding a return for operators and conditions for sustainable competition;
b) Active participation in the deployment of NGA both through investment subsidies and by investing directly (often through PPPs, local authorities or the granting of concessions for the operation of NGA networks), particularly in rural and more remote regions, where investment is more risky and competition more difficult.

With respect to the strategies followed by the operators, it can be said that investments seem to focus on urban centres, where competition is possible and, in many cases, is already a reality. There is also some preference for FTTC over FTTH, although both scenarios remain valid.

With regard to the NRA, its role, particularly in an EU context, is reflected in the guarantee - through a regulatory framework which is simultaneously stable, transparent and predictable -

of a climate which is conducive to investment throughout the national territory and is also conducive to the development of competition.

In this context, the main challenges that are anticipated for the NRA will, in particular, be related to achieving a balance between promoting investment in rural and remote areas and opening up networks in these areas through the implementation and ongoing oversight of potential wholesale obligations on markets related to NGA. This is coupled with analysis of whether or not vertical functional separation solutions are needed to facilitate the development of NGA, with the implementation of infrastructure record systems, with a range of issues arising from the widespread provision of bundled offers (e.g. analysis of predatory practices, relevant costs, SMP leverage in adjacent markets), and issues associated with net neutrality (e.g. levels of quality of service, free choice of services and non-discrimination).

The European regulatory framework is in a period of adjustment in light of the regulatory challenges mentioned above, noting the recent completion of the EC Recommendation on regulated access to NGA networks, which underlines the importance given to open access to these networks, at prices related to costs including a fair return on risk. Meanwhile, from the perspective of EC and with respect to migration from existing networks to NGA networks, it is equally important to ensure that alternative providers (in particular those currently benefiting from local loop unbundling) are provided with conditions which are transparent and reasonable and which are disclosed in a timely manner.

Note should also be made, at a European level, of the Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks, according to which government action is justified to ensure that areas which operators consider non-profitable (i.e. areas where broadband networks do not exist and are not expected to be deployed in the near future by private agents, as well as areas where only a single broadband operator is present) benefit from the positive effects of NGA, avoiding a digital divide between these and other areas. It is also noted that these guidelines also highlight the need for an open access network, where it has been subsidized.

As far as Portugal is concerned, the situation has been characterized above all by a clear dynamism among operators founded on a determined and consistent regulatory activity, and state stimuli (even where non-monetary) to NGA development.

In terms of ICP-ANACOM's remit, note is made of the pioneering role of the reference ducts access offer determined by ICP-ANACOM – this reference offer has served as an example, at a worldwide level, of an offer which facilitates investment in NGA. Meanwhile, note is also

made of ICP-ANACOM's continued role of providing advice to the government with regard to several of the measures outlined above and measures of general scope which maintain a transparent and predictable climate which is conducive to investment, and of the regulator's work in the development of market analyses, public consultations, the definition of technical specifications and review of wholesale reference offers, with a view to contributing to the elimination and reduction of vertical and horizontal barriers to NGA deployment and to ensuring appropriate conditions for migration from traditional networks to NGA networks.

The combination of government initiatives and regulatory measures undertaken have driven operator investments, whereby the number of households cabled with high-speed access already exceeds four million (70% with EuroDOCSIS 3.0 or equivalent and the remaining 30% optical fibre).

Even while, to date, the majority of investment has been focused on the most densely populated coastal regions, it is expected that NGA concessions awarded in rural areas will soon contribute to the national drive for digital inclusion.

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List of Acronyms

ACCC - Australian Competition and Consumer Commission.

AdDP - Águas do Douro e Paiva, SA.

ADSL - Asymmetric Digital Subscriber Line.

ADSL2+ - Asymmetrical Digital Subscriber Line 2+ (Internet access technology in accordance with standard ITU-T G.992.5; download speed of 25 Mbps).

AGCOM - Autorità per le Garanzie nelle Comunicazioni (NRA of Italy).

ALA - Ethernet Active Line Access.

AMDE - Associação de Municípios do Distrito de Évora (Association of Municipalities of the District of Évora, Portugal).

ARCEP - Autorité de Régulation des Communications Électroniques et des Postes (NRA of France).

ARPU - *Average Revenue Per User.*

AT&T - American Telephone & Telegraph Company (Historic operator of the United States).

ATKearney – Management Consultants.

AUD - *Australian Dollar*

AWG - *Arrayed WaveGuide* (Filter).

BCN - *Broadband Convergence Network* (Programme in South Korea).

BDIG – Base de Dados de Informação Geográfica (Geographic Information Database).

Beeline – Alternative electronic communications operator from the Russian Federation.

BEREC - Body of European Regulators for Electronic Communications.

Bitstream – virtual network access.

BNetzA - Bundesnetzagentur (NRA of Germany).

BPON - *Broadband PON.*

Bredbandsbolaget – Alternative operator from Sweden.

BT - British Telecom (Historic operator of United Kingdom).

BTC - Building Telecommunications Cabinet.

Cabovisão - Cabovisão S.A. (Alternative electronic communications operator from Portugal).

CDC - Caisse des Dépots et Consignations.

Central Office (CO) – Exchange side, as opposed to user side (CPE).

CEO - *Chief Executive Officer.*

CFH - Crown Fibre Holdings (New Zealand State holding).

CGCT - Code Général des Collectivités Territoriales (General Law over Regional Administrative Structures).

Chinese wall – Set of procedures and internal policies of an institution which seek to establish a barrier to communications between different individuals or departments of the same company, in order to ensure compliance with legislation on the separation of the management of third party resources from the institution's remaining activities.

Chunghwa Telecom - Historic operator of Taiwan.

Churn - Churn rate – is the proportion of customers who quit a service of a company over a year and switch to another company, generally due to more favourable conditions (e.g. price)

CIS – Centralised Information System.

CitéFiber - Alternative electronic communications operator from France.

Citylink - Alternative electronic communications operator from New Zealand.

Citynet Amsterdam – Largest broadband initiative in The Netherlands with 40 thousand people connected to an FTTH network.

CMTS - *Cable Modem Termination System*.

COCOM – European Commission Communications Committee.

Comcast - Comcast Corporation (Alternative electronic communications operator from the United States).

Comhem - Alternative operator from Sweden.

CPE - Customer premises equipment.

CRIP - Comité dês Réseaux D'initiative Publique (Committee of Public Initiative Networks).

DOCSIS 3.0 - *Data Over Cable Service Interface Specification* (Interoperability standard of cable access technology published in 2006. It supports IP traffic over digital TV channels, allowing downstream/upstream speeds of 400/100 Mbps.

Downlink – Downstream link.

Download – To download (Regarding the transfer of information between computers, the person receiving the information refers to the transfer as a download).

DSLAM - Digital Subscriber Line Access Multiplexer.

DSP - *Délégations de Service Public.*

DT - Deutsche Telecom (historic operator of Germany).

E.U. – European Union.

EAFRD – European Agricultural Fund for Rural Development.

EC – European Commission.

EERP - European Economic Recovery Plan.

EIB – European Investment Bank.

EOO - Equivalence of outcomes.

EPON – Passive Optical Network Technology, divided into two main technologies: EPON (IEEE 802.3) more commonly used in Japan and South Korea.

ERG - European Regulators Group.

Ericsson – Manufacturer of electronic communications equipment.

Ethernet – Technology frequently used in the physical interconnection of Local Area Networks (LAN), based on packet sending. It was originally created as a project of Palo Alto Research Center (PARC) of Xerox in the USA. After joint development with other companies, in 1980, it came to correspond to a protocol. Its designation derives from functioning related to various network points sending messages, similar to a wireless system, supported by a channel sometimes known as the ether, due to a reference to Luminiferous Aether, a term used to describe what certain 19th century physicists considered as a medium for the propagation of light

FANOC - Fibre Access Network Operating Company (Alternative electronic communications operator from Australia).

FastWeb - Alternative electronic communications operator from Italy.

FCC - Federal Communications Commission (NRA of the United States).

FICORA - Finnish Communications Regulatory Authority (NRA of Finland).

FiOS - Fibre Optic Service (An Internet, telephone and TV service from Verizon using FTTP).

Free - Alternative electronic communications operator from France.

FT / Orange SA - FT (Historic operator of France).

FTS – Fixed Telephone Service.

FTTB - Fibre to The Building.

FTTC – Fibre to The Curb.

FTTCab - Fibre to The Cabinet.

FTTH - Fibre to The Home.

FTTLA - Fibre To The Last Amplifier.

FTTN - Fibre to The Node.

FTTP - Fibre to The Premises (equivalent to FTTH).

FTTX - Fibre to The X (general term for any broadband network architecture which uses optical fibre to substitute the whole or part of the local loop, usually of copper)

Gbps - Giga bits per second.

GPON - Gigabit PON.

HanseNet - Alternative electronic communications operator from Germany.

HFC - Hybrid Fibre Coaxial (hybrid fibre – coaxial cable network).

HKBN / CTI - Hong Kong Broadband Network (HKBN) is the only subsidiary of Hong Kong's City Telecom (CTI). (Alternative electronic communications operator from Hong Kong).

Huawei – Chinese Manufacturer of electronic communications equipment.

ICT – Information and communication technologies.

IDA - Infocomm Development Authority of Singapore.

IDATE – European consultancy firm specialising in the electronic communications market.

Interface – Interoperability (Interface facilitating communication between the computer and its user (graphic or text), or between two applications or even two devices).

IPTV – Internet Protocol TV.

ISP - Internet Service Provider.

ITED - Infra-estruturas de telecomunicações em edifícios (Telecommunications infrastructure in buildings).

ITUR - Infra-estruturas de telecomunicações em loteamentos, urbanizações e conjuntos de edifícios (Infrastructures for telecommunications in housing developments, urban settlements and concentrations of buildings).

KDDI - KDDI Corporation (Alternative electronic communications operator from Japan).

KII - *Korean Information Infrastructure initiative.*

KPI - *Key Performance Indicators.*

KPN - Koninklijke PTT Nederland (Historic operator of the Netherlands).

KT - Korea Telecom (Historic operator of South Korea).

LAN - *Local Area Network.*

LFC – *Local Fibre Companies.*

LG Powercom - Life's Good (Alternative electronic communications operator from South Korea).

LLU – Local Loop Offer.

LLU - Local Loop Unbundling.

LTE - Long Term Evolution (Mobile broadband Internet access technology according to 3GPP or 4G standard).

Mbps - Mega bits per second.

MDU - Multiple Dwelling Units.

Mediafibre - Alternative electronic communications operator from France.

Metroweb - Alternative electronic communications operator from Italy.

MIC - Ministry of Information and Communication (South Korea).

MMDS - Microwave Multi-point Distribution Systems.

MPLS IP - Internet Protocol/MultiProtocol Label Switching.

MpoP - Metropolitan Point of Presence.

Multicast - Simultaneous delivery of information to multiple destinations using the most efficient strategy.

Naked DSL – Wholesale model which enables provision of an ADSL service to a consumer without the consumer needing to contract or maintain a fixed telephone service.

Net Neutrality – The principle whereby non-discriminatory access must be guaranteed for any type of traffic and content on the network.

Netcologne - Alternative electronic communications operator from Germany.

NGA - Next Generation Access Networks.

NGMN - Next Generation Mobile Networks.

NGN - Next Generation Networks.

NIA - National Information Society Agency (Government Agency of South Korea).

NITA – National IT and Telecom Agency (NRA of Denmark).

NRA – National Regulatory Authority.

NTT - Nippon Telegraph and Telephone Corporation (Historic operator of Japan).

Numericable - Alternative electronic communications operator from France.

OAO – Other alternative operators.

ODN – Optical Distribution Network.

OECD – Organisation for Economic Co-operation and Development.

OFCOM - Office of Communications (NRA of the United Kingdom).

OF-DF: Main Optical Fibre Distribution Frame.

OLT - Optical Line Termination.

Oni Communications - Alternative electronic communications operator from Portugal.

ONT - Optical Network Terminal (Interface between OF line between electronic communications company and the lines to the building).

ONU - Optical Network Unit.

OPEL - OPEL Networks Pty Ltd (Alternative electronic communications operator from Australia, formed by the association of two Australian electronic communications companies, Optus and Elders).

OPTA - Onafhankelijke Post en Telecommunicatie Autoriteit (NRA of The Netherlands).

OSP - *OutSide Plant*.

OSP Cabinet – Street cabinet where switch is located

Planning, SA – Consultancy company.

PON - Passive Optical Networks.

POSC - Programa Operacional da Sociedade do Conhecimento (Knowledge Society Operational Programme).

PPP – Public-Private Partnership.

Premium customers - Customers who pay an additional value for electronic communications services not included in the basic tariff.

PTC - PT Comunicações S.A (historic operator of Portugal).

PTS - Post- och Telestyrelsen (NRA of Sweden).

QoS – Quality of Service.

Qwest - Qwest Communications International, Inc. (Alternative electronic communications operator from the United States).

RBOC - *Regional Bell Operating Companies*.

RCTS - Rede Ciência Tecnologia e Sociedade (Technology and Society Network).

RDAO - Reference Duct Access Offer.

RF overlay - Transmission over a optical fibre of the analogue video signal.

RUO – Reference Unbundling Offer.

SDF - Sub-loop Distribution Frame.

SEM - Société d'Economie Mixte.

SFR - Alternative electronic communications operator from France.

SIVU - Syndicat Intercommunal à Vocation Unique pour la Télédistribution (Single-Purpose Intercommunal Syndicate for Cable Television).

SK Broadband - South Korea Broadband (Alternative electronic communications operator from South Korea).

SLU - Sub Loop Unbundling.

SMP – Significant Market Power.

Sonaecom - Sonaecom SGPS (Alternative electronic communications operator).

Splitter – Wavelength splitter.

Switched – A switched architecture of FTTH networks (commonly Active Ethernet).

TDMA - Time Division Multiple Access.

Tele 2 - Alternative operator.

Telecom New Zealand - Historic operator of New Zealand.

TeliaSonera - Historic operator of Sweden.

TeliaSonera Skanova Access AB – Subsidiary of TeliaSonera holding wholesale network infrastructure.

Telstra - Telstra Corporation (Historic operator of Australia).

TI - Telecom Italia (Historic operator of Italy).

Triple play – Offer of three electronic communications services combined in a bundle, normally telephone, Internet and Television

Triplexer – Terminal equipment with capacity to convert optical signals into electronic signals.

TUANZ – New Zealand consumer association.

UBCN - Ultra broadband convergence network (programme developed in South Korea).

UMIC - Agência para a Sociedade do Conhecimento (Knowledge Society Agency).

Uplink – upstream link.

Upload – To upload (Regarding the transfer of information between computers, the person

sending the information refers to the transfer as a upload).

Utilities – utility companies (water, gas, electricity)

U-Verse - AT&T U-verse (Commercial names of AT&T's services of FTTP to end-customers).

VDSL - Very High Speed Digital Line Subscriber.

Vector - Alternative electronic communications operator from New Zealand.

Verizon - Verizon Communications, Inc. (Alternative electronic communications operator from the United States).

VFS - Vertical Functional Separation.

Video-on-line - Electronic communications service which enables viewing of video over the Internet.

VOD – Video-on-demand.

Vodafone - Electronic communications operator.

VoIP – Voice over IP.

WBA - Wholesale broadband access.

WDM-PON - Wave Division Multiplexing Passive Optical Network (Access architecture).

WiMAX - Worldwide Interoperability for Microwave Access (Technology of access to mobile broadband Internet according to the standard IEEE 802.16).

Wind - Alternative electronic communications operator from Italy.

Won – Currency of South Korea.

Woosh - Alternative electronic communications operator from New Zealand.

xDSL - *x Digital Line subscriber* (of any type).

ZON - Serviços de Telecomunicações e Multimédia SGPS, S.A (Alternative electronic communications operator from Portugal).