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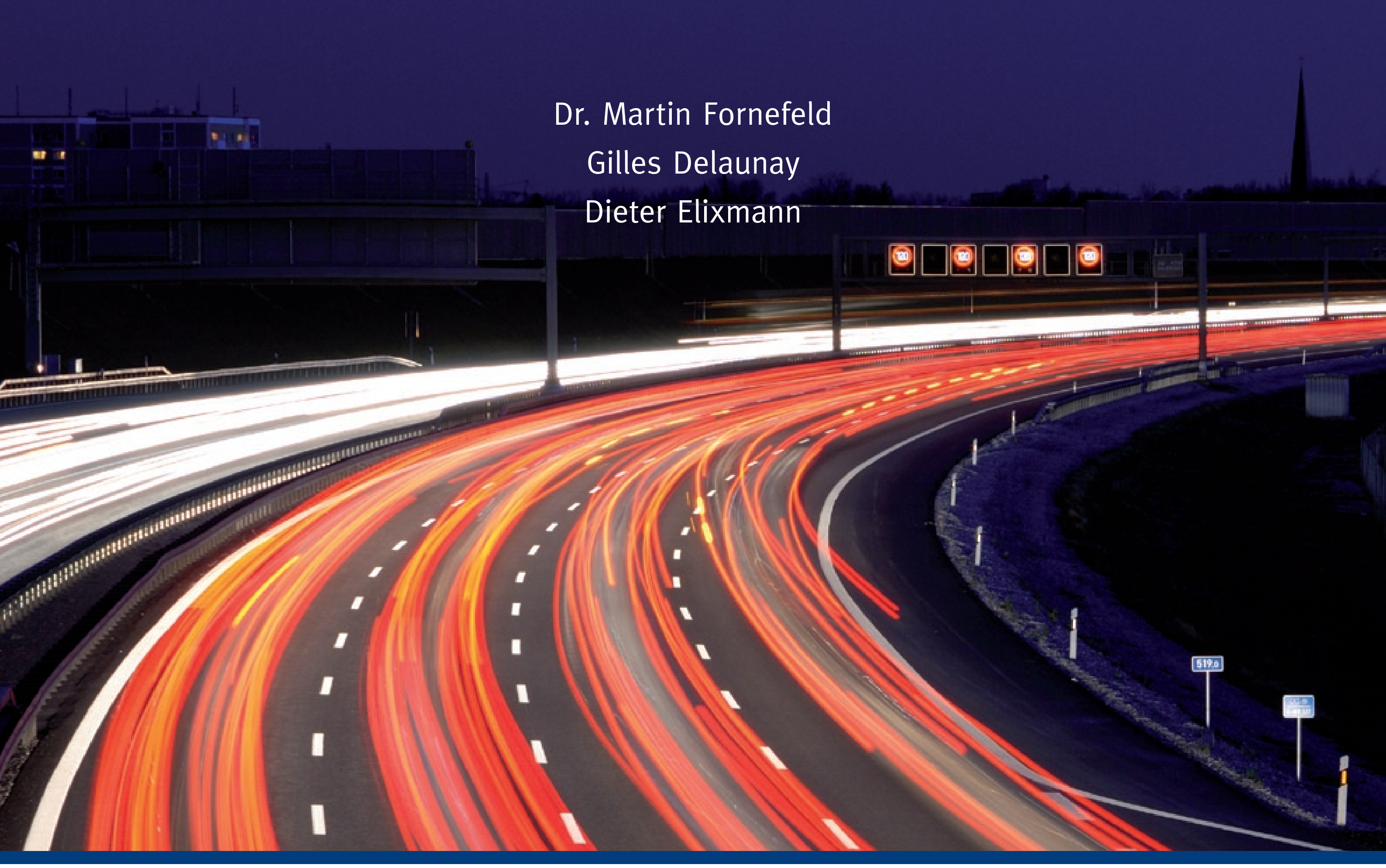

The Impact of Broadband on Growth and Productivity

A study on behalf of the European Commission
(DG Information Society and Media)

MICUS
Management Consulting GmbH

Contents

The opinions expressed in this study are those of the authors and do not necessarily reflect the views of the European Commission.

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Published 2008

Executive summary

The Lisbon strategy aims to make the EU "the most dynamic and competitive knowledge-based economy in the world" by 2010. It was relaunched in 2005 and refocused on the creation of growth and jobs. The objective of this study is to assess the contribution of broadband internet telecommunications to this strategy by evaluating its impact on growth and productivity.

Studies of the development of broadband generally focus on the provision of telecommunications services. In order to analyze all economic impacts, this study broadens the scope of attention by considering the use of value-added services over the telecommunications infrastructure. Three composite indicators establish a portrait of broadband adoption in Europe between 2004 and 2006, on the basis of statistical data from the European Commission and Eurostat:

- development of the broadband infrastructure
- readiness of the population to use broadband-based technologies: IT skills, affinity towards new technologies, awareness for the benefits of broadband
- integration of broadband-based services into companies' processes.

The following telecommunications technologies are considered "broadband": ADSL, VDSL, cable modem, fibre optics, wireless, satellite internet, mobile broadband (UMTS, HSPA) and internet through the electric power transmission network (Powerline). Predictions about the development of the broadband infrastructure over the period 2006–2015 are founded at the country level on a review of the development plans of the main telecommunications services providers. Broadband penetration is expected to reach 81% of all households by 2015, including households using broadband over mobile technologies and which do not subscribe to a fixed-link telecommunications access. The VDSL and FTTH/B infrastructures are unlikely to be developed on a wide scale in Europe before 2010.

In order to support the analysis with concrete results, two regional broadband development programmes were investigated, in Cornwall (UK) and Piedmont (IT). Both programmes focus on the adoption of value-added broadband services in companies and in public services. Four years after the start of the actnow programme, 10% additional yearly growth and 7% additional productivity increase per year in the business services sector can be observed in Cornwall as compared to the rest of the country. Two years after the start of the WI-PIE programme, the regional IT observatory recorded progress of 9% per year on average in the regional broadband-related economic indicators.

Previous assessments of the impact of broadband on growth were based on statistical correlations between broadband development and economic prosperity. In order to provide a more detailed understanding of the way broadband impacts the companies' activity, the present analysis models broadband-related productivity improvement, structural displacements within the economy and innovation-driven growth.

- Process improvement: According to the available literature, companies adopting broadband-based processes improve their employees' labour productivity on average by 5% in the manufacturing sector and by 10% in the services sector. Due to the slow adoption of broadband-based value-added services in Europe and in particular among SMBs (3% per year on average), the macro-economic broadband-related productivity improvement in Europe evaluates to 0.29% on average per year over the period 2004–2006.
- Specialization in knowledge-intensive activities: The development of broadband allows the acceleration and automation of information flows between companies, which enables an increased specialization in knowledge-intensive activities. This structural evolution in business environments generates a displacement of 725,000 jobs per year in Europe from traditional economic sectors to the business services sector. This displacement mostly concerns activities, such as IT services, engineering, accounting, legal and financial services or research activities, generally described as knowledge-intensive business services (KIBS). It yields a productivity improvement of 0.15% per year at the European level and fosters innovation.
- Broadband-based innovation: Service innovation and process innovation in knowledge-intensive activities strongly rely on broadband technologies. This kind of innovation is crucial for the development of new markets and economic growth in developed economies. Results from the model assess the creation of 440,000 jobs in the business services sector in 2006 and 549,000 jobs in other economic sectors due to broadband-related innovation in knowledge-intensive activities. This employment creation compensates for the loss of jobs due to process optimization and structural displacements within the economy. The impact of broadband on employment is positive, with a net creation of 105,000 jobs in 2006 in Europe.

According to the model, process improvement, increased specialization in knowledge-intensive activities and broadband-based development of innovative markets resulted in a growth of the European Gross Value Added (GVA) of € 82.4 bn per year (+0.71%) in 2006. The impact of broadband on national economies depends on the level of broadband development: in the most advanced European countries, broadband-related GVA growth reaches 0.89%, whereas in the countries with less-developed broadband, this growth is limited to 0.47%.

The speed of broadband development is not neutral as regards economic impact: the successful development of innovative activities, which constitutes a large share of the positive impact of broadband, requires remaining at the forefront of worldwide development. Three scenarios quantify the importance of the speed of adoption of value-added online services:

- The base case corresponds to a constant adoption rate until 2015 equal to the European average over the period 2004–2006. According to the model, broadband development would in this case contribute to the creation of 1,076,000 jobs in Europe and a broadband-related growth of the economic activity of € 849 bn between 2006 and 2015.

- In the best case, the European average adoption rate increases progressively until 2015 up to the adoption rate observed in the most advanced European countries over the period 2004–2006. In this case, broadband development would contribute to the creation of 2,112,000 jobs and € 1080 bn of economic activity between 2006 and 2015.
- In the worst case, the European average adoption rate decreases progressively until 2015 down to the adoption rate in the less-developed European countries over the period 2004–2006. In this case, broadband development would result in the creation of 345,000 jobs and € 636 bn of economic activity.

In order to maximize the economic benefits of broadband, action at the political level is necessary:

- **Develop the broadband infrastructure.** E-inclusion in the less-advanced European regions and the development of the fibre-to-the-home (FTTH) infrastructure in the most advanced areas are major challenges for a successful development of the knowledge society in Europe.
- **Rely strongly on education for a long-term development of the knowledge society.** Spread IT skills within the population and increase autonomy in the learning process by developing the online availability of educational and technical resources.
- **Foster the use of online technologies in businesses, public services and by individuals.** E-government should become the rule, not the exception, for the exchange of information between public services and companies (B2G) as well as within public services (G2G). Business services providers and professional organizations should be incited to play a role in the adoption of online services in SMBs.
- **Promote the development of innovative online services.** Innovation policies are key to maximizing the benefits from broadband development by increasing internal markets for online services and exporting high value-added technologies and services to the rest of the world.

Broadband internet is a general-purpose technology with a strong impact on knowledge-intensive activities in all economic sectors. It is essential to the creation of sustainable jobs and economic activity in fast-growing, high-value-added economic sectors. A strong integration of value-added online services into the companies' processes, key to a high economic impact of broadband, results from the combined development of the telecommunications infrastructure and the improvement of people's readiness to use broadband technologies.

Introduction

Internet technologies are largely used in companies, in public services and by individuals. They have become an indispensable support for information flows in the economy, and provide individuals with access to a very large quantity of information and services at home, at school or at work. Since the popularization of the internet over dial-up technologies in the 1980s and 1990s, the development of the broadband infrastructure has greatly increased the possibilities of the worldwide web, making it possible to integrate the internet even further into business processes and services, and deliver multimedia content to a large number of consumers.

The internet is far from being a static or mature technology: it is still evolving very quickly, as new applications continue to emerge. The development of new online services or internet-based processes is the support for essential innovation and economic growth in all sectors of the economy and public services. In all European countries, the internet is increasingly present in the life of individuals, for learning or taking part in social communities. The internet phenomenon, now "mobile" over UMTS and HSDPA or with more than 50 Mbit/s bandwidth over optical fibre infrastructure, does not show signs of weakness or slowing down for the next years.

At the same time, the European economy is put under heavy pressure by the "new economy". More and more office tasks can be automated, while thousands of jobs are off-shored to low-cost countries where the salaries of highly educated workers are lower than in western Europe. By providing instant information transfers over long distances, broadband internet is also an instrument of the worldwide competition between workers and between territories. Are the positive impacts of the internet on the economy larger than the negative ones? Is there a reasonable way to take more advantage of broadband development, while limiting the inherent risks? The issues at stake are crucial to sustaining a high level of employment and economic activity in Europe.

In Lisbon in March 2000, the European Commission decided to implement a strategy aimed at making the EU "the most dynamic and competitive knowledge-based economy in the world" by 2010. At the mid-term review of the Lisbon strategy, the European Commission and the European Parliament simplified and refocused the Lisbon agenda on the creation of growth and jobs in a future-oriented European knowledge society.

This study has been commissioned by the Directorate General Information and Media of the European Commission in order to provide policy makers with a quantitative evaluation of the impacts of broadband technology on the European economy. This research has been undertaken at a very interesting time, when the calculation of such impact is far from trivial, but intense work and numerous datasets are available worldwide and provide a basis for a quantitative analysis of the impact of broadband. This study not only draws attention to figures and results; it also provides elements of a structural analysis of the way broadband influences evolution in the economy and contributes to growth and employment creation in Europe.

Section 1 gives an overview of the available broadband technologies, for non-specialist readers. Essential statistics and empirical evidence of the broadband development in Europe are presented, in Section 2, and synthesized in three composite indexes. These indexes highlight disparities in the development of broadband infrastructure across the European member states and provide a basis for grouping the countries according to their broadband development. Before going further in the analysis, Section 3 describes cases of successful broadband development in Cornwall (UK) and Piedmont (Italy), and their impact on the local economy. Section 4 analyzes the impact of broadband on productivity for several kinds of users, at the micro-economic and macro-economic level. These results are used in Section 5 to assess the impact of broadband on growth and employment. Sections 6 and 7, respectively, present development scenarios until 2015 and policy recommendations for successful development of broadband in Europe.

We wish the reader the same interest and enthusiasm as we had during the construction of the following framework and analysis of the impact of the internet on the European economy.

1 Broadband technologies

There is no generally accepted definition of the term "broadband". Definitions based on data transfer speed are not able to take into account the very fast evolution in technologies and uses. Is a bandwidth of 256 kbit/s a broadband connection? Should the lower limit be set to 1 Mbit/s? There is no definitive answer as the bandwidth required to run internet applications is continuously increasing and infrastructure standards are also continuously improving to face the growing demand. Such a definition can only be relative to a particular moment in time in a particular country.

The OECD, for its working party on telecommunications and information services policies [96],[1] uses the following broadband definition from the US Computer Science and Telecommunications Board (CSTB): *A local access link is viewed as broadband if the performance of the link is not a limiting factor in a user's capability for running today's applications. Moreover, they point out the importance of broadband in innovation: Broadband service should provide sufficient performance – and wide enough penetration of services reaching that performance level – to encourage the development of new applications.*

Use a definition based on functionality rather than bandwidth

In the present study, we also use a definition based on functionality rather than bandwidth. All technologies able to support modern applications are considered here broadband technologies, though some of these technologies can also be used for low-performance communications. The characteristics of the broadband technologies presented here should ease the reading of the report for non-technicians. More information on each technology is presented in the corresponding appendix.

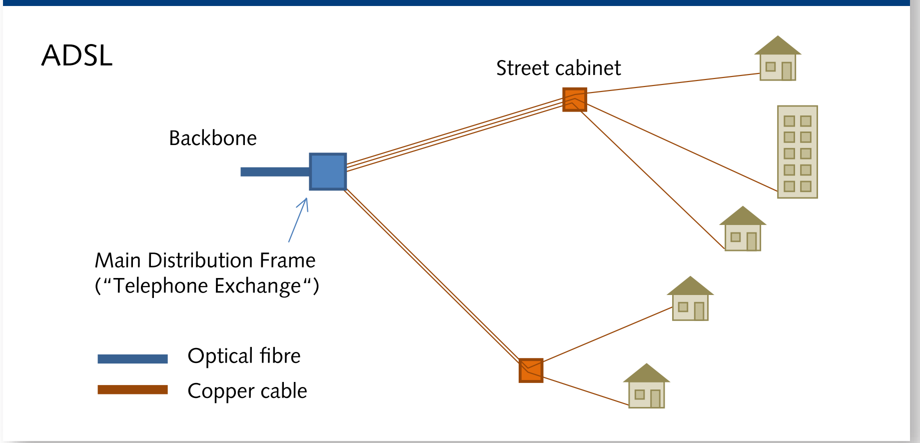
[1] All quotations in square brackets refer to the bibliography at the end of the report.

1.1 ADSL

ADSL is the most used broadband technology in Europe

Asymmetric Digital Subscriber Line (ADSL) enables access to the internet via the existing copper infrastructure of the incumbent telecommunications service provider. ADSL and ADSL2+ are asynchronous technologies with a downstream capacity much higher than the upstream capacity. Asymmetric technologies are best adapted for services such as information research, after-sales services or e-government, where the user is mainly a "receiver" of data, but they are suboptimal for two-way use of the internet, such as videoconferencing or database sharing.

Figure 1 – ADSL technology in the local loop (schematic view)



Burying cables is the main cost driver for network deployment, particularly in the "last mile" of the distribution network where a lot of branching is necessary to connect each user to the infrastructure (local loop). A carrier eager to upgrade the performance of his network has an inherent incentive to avoid laying new cables. ADSL provides such an opportunity as it is based on the existing infrastructure, namely the local loop of the traditional telephony network (see Figure 1).

Key topics – ADSL

- ADSL re-uses the existing local-loop, copper-wire architecture, thus reducing the investment needed to reach each house: it is the preferred solution for a telecommunications company to provide broadband access to its customers.
- The bandwidth diminishes sharply when the length of the copper link increases: ADSL technologies have limited reach in rural areas.
- Despite continuous technological improvement, the available bandwidth is too low for multimedia applications such as HDTV: an extension of the optical network is required in the short- to medium-term.

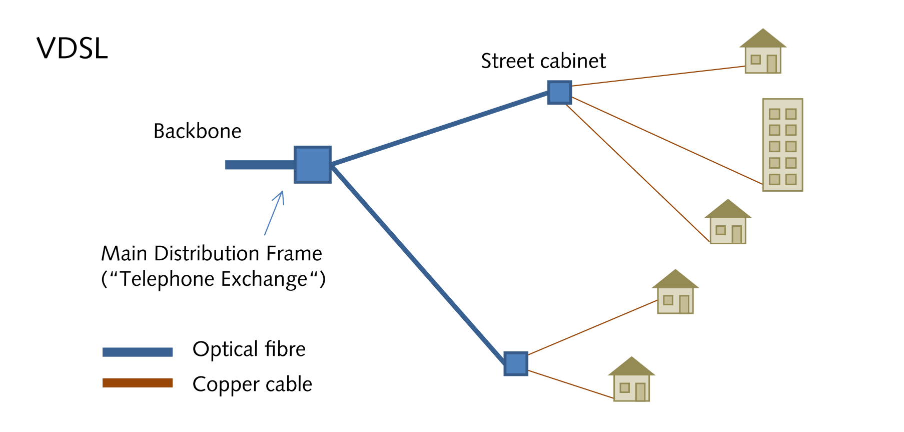
1.2 VDSL

VDSL technologies are conceptually very similar to ADSL, but the length of the copper link is reduced by a partial upgrade of the local loop with optical fibre. A typical bandwidth of 1–10 Mbit/s for ADSL can be improved to 10–50 Mbit/s with VDSL, depending on the length of the copper link.

Digging is expensive

In a VDSL environment (see Figure 2), fibre strands are deployed between the main distribution frame (MDF) and street cabinets. Only the part of the network between the street cabinets and the end user consists of copper lines. This new network topology requires important investment to upgrade the street cabinets and the MDF becomes superfluous.

Figure 2 – VDSL technology in the local loop (schematic view)



Deployment of VDSL technology is expensive, if digging is required to lay down optical fibre downstream from the Main Distribution Frames (MDFs) to the street cabinets. In many cases, incumbent telephone companies can use their existing ducts containing the copper infrastructure. Competitors, however, have to dig up streets in order to offer a VDSL-based service, unless they can get access to existing ducts or to dark fibre from the incumbent telephone services provider or third parties such as utility companies. An alternative is infrastructure sharing between several internet service providers using bitstream access. These issues are currently at the core of the regulatory discussions regarding VDSL.

Key topics – VDSL

- Incumbent telephone companies can deploy a VDSL infrastructure using their existing ducts without having to dig up streets, thus achieving important cost reductions. In order to provide similar services, access to existing ducts, street cabinets and optical fibre networks is critical for competitors that do not own a local-loop infrastructure.
- VDSL allows providers to offer "triple play", including high-definition TV over the telephone infrastructure. Nevertheless, the available bandwidth is still limited and can be expected to be insufficient for internet applications developed over the next ten years.
- VDSL is not suitable for low-density areas where the distances between the street cabinet and the end users are too long.

1.3 Cable modem

Cable TV networks have been deployed in many European countries since the beginning of the 1980s. At that time, these networks were designed to distribute the same information simultaneously to a large number of users, known as a "point-to-multipoint" topology. By comparison, a telephone infrastructure has a "point-to-point" topology. The coverage of cable TV networks differs a lot from one country to the other in Europe. Some countries, such as the Netherlands, have achieved nearly 100% coverage, while others, such as Italy, have no cable network infrastructure at all.

Originally designed to carry large quantities of information, the cable TV infrastructure is physically superior to the telephone infrastructure although it lacks the capability of sending information back from the user to the network (return path). Since the opening of the telecommunications markets in the 1990s, cable operators have had major incentives to upgrade their existing networks:

- implementation of the return path
- extension of the bandwidth capacity, including optical fibre deployment nearer to the customer (known as hybrid fibre coax, HFC).

In countries where an internet offering over cable TV has been developed, it has been observed that inter-modal competition between broadband over the cable TV infrastructure and the DSL infrastructure has increased the dynamism of the broadband market.

Key topics – cable modem

- Cable broadband is based on the existing cable TV infrastructure, after important upgrade and investment.
- It is a competitor to the DSL offering, with a different network topology but the same technical evolution: bring the optical fibre nearer to the user to increase bandwidth.
- There is uneven development across Europe, in many cases limited to urban areas: it is no solution to the digital divide.

1.4 Fibre to the home and fibre to the building

Fibre optic is a future-proof technology

Fibre-optic cables have long been used to transfer very high quantities of data over telecommunications backbones. Depending on the technology used at the connection point between two fibres, bandwidth of several Tbit/s (1,000,000 x 1 Mbit/s) can be reached with today's technology, showing that optical fibre is a mature, future-proof technology. Data transfer over optical fibre barely depends on the length of the link, making this technology also suitable for intercontinental communications or telecommunications networks in rural areas.

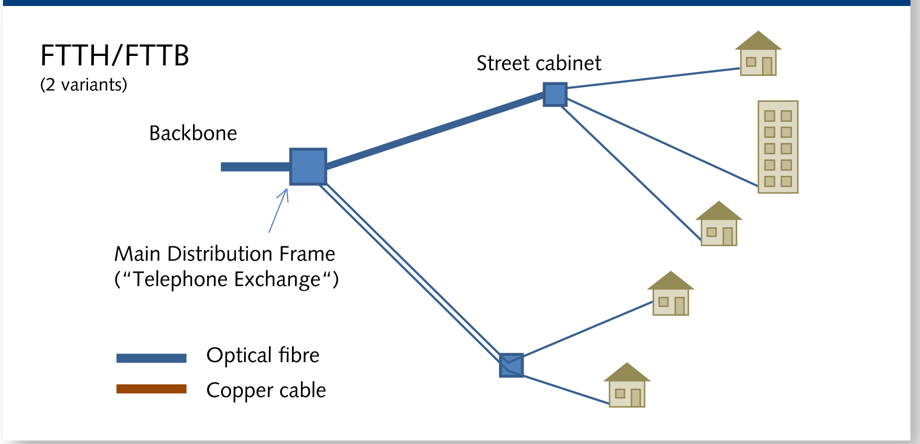
Since the 1980s, many countries' telephone infrastructures have already been upgraded to use digital, optical technology instead of the traditional copper networks as backbone technology to connect the local telephone exchanges (MDFs). This upgrade was required for digital data transmission over the telephone infrastructure (ISDN and ADSL) and made the telephone infrastructure easier to maintain. In order to face the new requirements of a modern telecommunications infrastructure, the infrastructure owners have to set up a strategy to bring the optical network even nearer to the user:

- Fibre to the home (FTTH): each home is directly connected to the telecommunications infrastructure through an optical fibre. A typical bandwidth of 100 Mbit/s, independent of the length of the link, can be reached. This solution, however, requires very heavy investment to replace or overbuild existing copper cables with optical fibres.

- Fibre to the building (FTTB): this technology is usually used in multiple-dwelling buildings. In this case, the building is connected to the telecommunications infrastructure through an optical fibre, each home being connected within the building to the fibre via the existing twisted pair or coaxial copper network, Wi-fi or powerline.

Figure 3 provides a schematic visualization of an access network based on FTTH and FTTB. Two variants are illustrated:

Figure 3 – FTTH/B technology in the local loop (schematic view)



- In a "point-to-multipoint" infrastructure (top), all fibres coming to a street cabinet are bundled into a single fibre between the street cabinet and the next bundling point. Such an infrastructure can be an upgrade of an FTTC or VDSL infrastructure (also called G-PON).
- In a "point-to-point" infrastructure (bottom), all houses are connected through a single optical fibre directly to the distribution frame.

Key topics – FTTH/B

- Optical technologies support much higher bandwidths than copper-based or wireless broadband technologies: in the foreseeable future, it will be able to support all kinds of broadband applications. The available bandwidth for an end user in an FTTH environment is, to a large degree, independent of the length of the fibre link. In a point-to-multipoint FTTH (G-PON) or FTTB environment, the available bandwidth to the end user mainly depends on the number of users sharing a single fibre strand.
- Bringing optical fibres to the end user requires heavy infrastructure investment to replace or overbuild the existing copper cables. Solutions allowing the reduction of costs, such as the re-use of existing ducts or the deployment of aerial cables in rural areas, should play an important role in speeding up the development of the infrastructure.

1.5 Fixed wireless access

A wireless broadband infrastructure can be deployed quickly in rural areas

Fixed wireless access (FWA) technologies are based on terrestrial radio systems and do not necessarily support mobility:

- Public Wireless LAN (PWLAN or Wi-fi hotspots) are local area computer networks providing radio-based data transmission over a range of around 100 meters. WLAN technologies as described in the IEEE 802.11 standards use public frequency bands, which has allowed Wi-fi networks to be deployed in many countries to provide broadband connections in buildings and public places or via a user-managed infrastructure such as FON (www.fon.com). However, the short reach of the link makes this technology unsuitable for a wide-scale infrastructure.

- Worldwide Interoperability for Microwave Access (WiMAX) is a range of technologies allowing data transfers over a radio link with a bandwidth of more than 50 Mbit/s over 20 to 100 km. WiMAX technologies can be used either as a backbone link (point-to-point, to connect a remote community) or a distribution network (point-to-multipoint, to cover an area with broadband connectivity). Regulations on the use of radio frequencies have been a major obstacle against the development of WiMAX so far. This technology could be used to provide broadband internet in regions where no telephone infrastructure is available. The bandwidth available to the end user in economically sustainable WiMAX developments is usually no higher than with ADSL technologies.
- Low-frequency wireless broadband or "digital dividends": the digitalization of the terrestrial television channels has allowed television frequencies to carry 10 to 40 times more usable information. These frequencies could be used to carry internet data, thus providing broadband internet services over long distances in rural areas, with less disturbance from the physical environment. This solution, though, would very quickly come to saturation.

Both WLAN and WiMAX technologies are sensitive to the environmental conditions: physical obstacles such as hills, trees and buildings; reverberation effects; and an uneven ambient temperature.

Key topics – fixed wireless access

- Wi-fi (WLAN) is suitable for short-range connections, in particular in urban areas.
- WiMAX technologies are under-developed because of national legislation on the use of radio frequencies. Provided the environmental conditions are favourable, these technologies could be used to solve temporarily the digital divide in remote regions where no suitable telephone infrastructure is available. As bandwidth needs continue to increase, it will be necessary in the end to upgrade the infrastructure with an optical fibre.

1.6 Mobile technologies

Mobile technologies originally designed to transfer voice are also suitable for data transfer. In this study, we focus mainly on UMTS-based mobile technologies, including the original UMTS as well as High-Speed Packet Access (HSPA) and Long-Term Evolution (LTE), which are updates of UMTS technologies.

The available bandwidth is quickly improving

The available bandwidth provided by current mobile technologies is still lower than the respective bandwidths provided by fixed-link ADSL 2+, VDSL or FTTH/B technologies. Moreover, within a particular cell, mobile technologies provide shared use of the available bandwidth. Simultaneous, intensive use of the mobile network within a specific cell by a large number of users sensibly reduces the bandwidth available for each user. However, the recent technical upgrade of mobile broadband networks from basic 3G UMTS technology to 3.5G HSPA and in the near future 3.9G LTE provide a remarkable increase of the available bandwidth, up to 7.3 Mbit/s for HSDPA currently used in some parts of Europe.

Mobile broadband is used very differently across Europe:

- in the areas where no fixed-link infrastructure is available, in particular in the new member states, mobile broadband is used as a substitute for wired broadband. In this case, the infrastructure quickly reaches its limits. Technological improvements and upgrades are key to increasing the average bandwidth available to the end user.
- in regions where wired broadband technologies are available, mobile broadband is used only for services where the ability to "go mobile" is important, for example: to find the nearest restaurant, use the internet during travel or exchange information between an employee working at a client's place and his company's IT system. The quickly increasing complexity and usability of handset devices (telephones, organizers, cameras, navigation systems, watches...) and the recent development of the market for UMTS access cards for notebooks allow the imagination of a complete new range of uses of the internet and innovative internet-based services for mobile users.

Mobile broadband is not a direct substitution for fixed broadband; it provides complementary functionalities. Both mobile and fixed-link broadband push the adoption of the internet in the population, and the development of the knowledge society. In the same way as "mobile only" users for voice services, in each country a certain number of households will be "mobile broadband only" users.

There is a large potential for growth in mobile data services

Key topics – mobile broadband

- Despite the quickly increasing available bandwidth due to recent improvements of the mobile broadband technologies, mobile broadband will not be able to replace fixed broadband technologies in the foreseeable future, in particular for business communications. Some households will choose to be "mobile-only": a fixed-link broadband penetration of 100% in households should not be expected.
- The dynamic of the market for mobile services in Europe varies a lot across the member states. On the one hand, most markets in EU15 countries come to saturation, while on the other hand, there is still remarkable growth in countries with a relatively low fixed-link penetration or a low mobile penetration. This is especially true in some new member states such as Romania and Bulgaria.
- Voice communications represent the larger share of mobile telecommunications services today. However, there is a large potential for growth in mobile data services in Europe.

1.7 Other technologies

1.7.1 Satellite

Satellite-based internet access solutions provide 100% broadband coverage in Europe, with bandwidth equivalent to ADSL access.

Satellite-based broadband connection is available everywhere in Europe

Two kinds of satellite internet access have to be distinguished:

- One-way satellite connection: the satellite link is used for the download link only, with bandwidth comparable to an ADSL download link. Narrow-band, dial-up modem or ISDN technologies are used to send information back to the internet (uplink). The overall monthly cost for this kind of access, including down- and uplink, is two to four times higher than a normal ADSL connection. Coverage is limited to the areas where the PSTN infrastructure is available.
- Two-way satellite connection: the satellite link is used both for the download and the upload link. Since the beginning of this century, this technology is basically available over all of the European territory, including in regions where no telephone access is available.

Until recently, because of higher costs and the need for technical competence, two-way satellite connections were mostly reserved for professional use, for example to connect to the internet off-shore oil platforms or logistics facilities. Recent improvements in the satellite telecommunications technologies allow two-way satellite connections to be offered to individual users (see Table 1).

Table 1 – Two-way satellite internet prices
Source: yato (Germany), 2008

Installation costs	Hardware costs	Monthly fee	Downlink/Uplink bandwidth
€ 119	€ 295 or € 9/month	€ 29.80	256/64 kbits/s
		€ 39.80	512/96 kbits/s
		€ 49.80	1024/128 kbits/s
		€ 79.80	2048/128 kbits/s

High response times due to satellite transmission prevents the use of real-time technologies such as VoIP or videoconferencing over a satellite link. Furthermore, in order to achieve profitability, a satellite link has to be closer to saturation than a terrestrial telecommunications infrastructure. This may result in a more variable quality of service for internet users.

Despite these drawbacks, satellite broadband should be considered as an alternative for connecting remote users in places where no terrestrial infrastructure is available.

1.7.2 Powerline

Powerline data transfer uses the electricity distribution network as a telecommunications infrastructure. Technologies for internet providers with bandwidth of up to 2.7 Mbit/s are available. Within a building, transfer rate of 50 Mbit/s can be reached.

The conventional wisdom in the market for communications services is that powerline data transfer is not very suitable as an internet infrastructure; rather, it may be used within a building to avoid laying new cables.

Key topics – satellite and powerline

- Due to higher costs and lower bandwidth, neither satellite nor powerline broadband are substitutes for ADSL, VDSL or FTTH/B broadband infrastructures.
- Satellite broadband is a valuable alternative to provide coverage in remote areas where no terrestrial infrastructure is available.
- Powerline broadband can be used as a competitor to wireless LAN for sharing an internet connection, such as FTTB, within a building, without laying new cables.

2 Evidence of broadband adoption in Europe

There are high disparities in broadband development across Europe

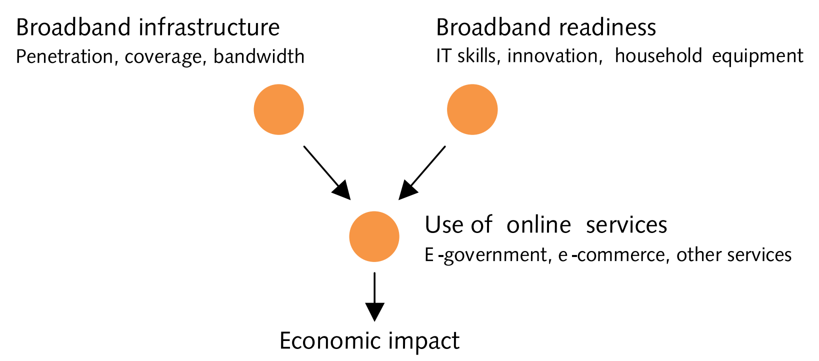
There are high disparities in broadband development across Europe, with some countries among the most advanced knowledge societies in the world and others which are just at the beginning of their evolution into a knowledge society. Understanding these differences and facing them with appropriate policies contribute to accelerating the development of the knowledge society in every country in Europe.

Demographic issues, economic structure, existing telephone infrastructure, education level and disparities in urban and rural areas between countries are historical and physical differences leading to different broadband development paths. Rather than a single linear development model, disparities among European countries illustrate the variety of ways a country can set priorities to tackle its structural limits and take advantage of its potential, in order to successfully develop a future-oriented knowledge society.

The development of the broadband infrastructure is a prerequisite

At the company level, broadband connectivity is a condition before employees can make use of online technologies. Broadband-related economic impact on the company requires, besides a broadband internet connection, the integration of online technologies into the company's process: sales, procurement, administration, services, research and development, etc.

Figure 4 – Factors influencing the adoption of online services



Human factors, or "readiness" of the employees and the management of a company, are essential for the integration of broadband-based technologies into a company's processes. These factors can take many forms: technical competencies, affinity with innovation, use of computers, etc. These fundamentals of broadband adoption should also be taken into account in an evaluation framework of the use of broadband technologies in companies.

Human factors are essential

In order to assess the economic impact of broadband, a framework for the evaluation of the integration of online services into companies' processes has to be developed. This evaluation framework has to be simple enough to be usable with the available statistics and take into account the many ways a company can integrate broadband-based technologies into its processes.

This section of the report deals with the construction of a suitable empirical framework that will provide a basis for the analysis of the impact of broadband on growth and productivity. This framework (see Figure 4) includes:

- the development of the broadband infrastructure
- the "broadband readiness" of a population or business environment
- the integration of online technologies into companies' processes.

2.1 Composite indicators for the development of broadband in Europe

The three factors referred to above – development of the broadband infrastructure, broadband readiness and use of online services – are essential elements for the assessment of an analysis of the economic impact of broadband. These factors are complex:

- The improvement of the broadband infrastructure results from a combination of the development of several technologies.
- The broadband readiness depends on many socio-economic factors, in particular in the fields of education, innovation and access to information and communications technology.
- There are many kinds of online services and broadband technologies that can be integrated into a company's processes. The "Community survey on ICT use in enterprises" provides a number of indicators on the use of these technologies.

Composite indicators combine several measures into a single indicator

It is possible to define three sets of single indicators representing partial aspects of each of the three factors. Each of these single indicators gives a partial measure of the complex tendency under consideration. The construction of composite indicators is a statistical tool that allows the combination of these measures into a single indicator.

Altogether, 35 sub-indicators were used to construct the following three composite indicators. Most of them were provided by Eurostat, in particular the "Community survey on ICT use in enterprises", 2006 edition. The methodology used for this survey is described in the corresponding manual from Eurostat [51].

The sub-indicators were selected upon the following criteria:

- quality of the source
- availability of the data for as many European countries as possible
- consistency between the sub-indicators of a single composite indicator.

Within each composite indicator, the sub-indicators have been grouped into categories, each category being attributed a weight of 1. When necessary, the data has been normalized with the maximal value being equal to 100. Missing values have been inferred by similarity with the other values in the same category. For more information about the construction and validity of composite indicators, see also the "Handbook on constructing composite indicators" (OECD) [95].

2.1.1 Infrastructure development

Coverage

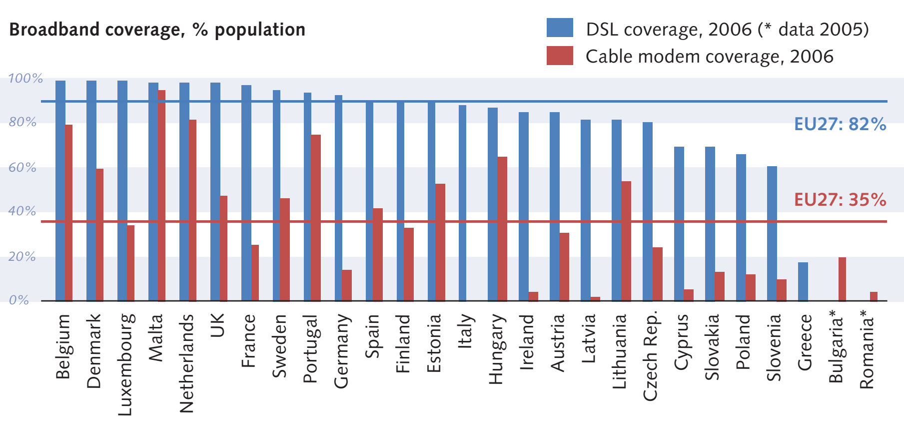
In principle, through dial-up modem or two-way satellite technologies, the internet is available everywhere in the European area. However, due to bandwidth constraints and price, these two technologies have a limited impact on the adoption of online services.

DSL technologies, now available to 82% of the population in the EU27 (Source: IDATE 2006), have played a major role in the adoption of online technologies and services. They were most successful in countries with a well-developed telephone infrastructure. Competition between incumbent and new entrant telecommunications service providers offering DSL technologies (intra-modal competition) was improved by local-loop unbundling (LLU) regulations. Furthermore, in countries equipped with a cable TV infrastructure, competition between DSL and cable modem technologies (inter-modal competition) has increased the dynamism and investment levels in broadband infrastructures (see Figure 5).

The fixed-link broadband infrastructure reaches 82% of the European population...

Despite continuous technological progress, limitations inherent to DSL technologies make them unusable in scarcely populated areas with long distances between the end users and the nearest telephone exchanges, or in regions of eastern Europe where most houses are not connected to the telephone infrastructure.

Figure 5 – Broadband coverage in EU27



Further increases in coverage will require an extension of the optical fibre network in combination with DSL technologies and use of wireless technologies in regions with insufficient copper infrastructure.

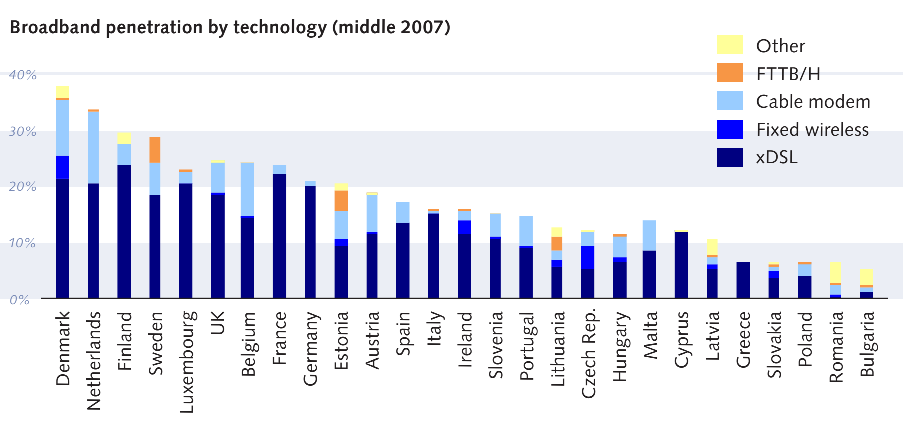
Source Figure 5: IDATE and Screen Digest

Penetration

Broadband coverage represents the availability of the broadband infrastructure. Many households or companies have the possibility of subscribing to a broadband connection, but do not do so for many reasons. Broadband penetration represents the actual broadband connectivity among a population or businesses.

... but not all of them subscribed to a broadband connection

Figure 6 – Broadband penetration by technology, % of population, July 2007



Source Figure 6: Our calculations are based on "Broadband access in the EU: situation at 1 July 2007" (European Commission) [38]; IDATE

Technologies and bandwidth

Japan and South Korea have strongly invested in the development of a fibre-optic infrastructure (FTTH/B), with the support of public authorities. The number of FTTH/B subscribers in Japan is currently estimated at 10 million, for about 127 million inhabitants [127]. In comparison, the FTTH/B infrastructure in Europe is, in most cases, limited to privileged urban areas (such as Amsterdam, Paris, Cologne). Currently, hardly more than 1 million broadband subscribers in the EU27 have FTTH/B connections, for more than 497 million inhabitants [127].

Connections with a bandwidth of more than 10 Mbit/s downstream are considered key to the development of "triple play" (internet, telephone and TV) offerings, which are supposed to boost penetration. Entertainment applications are very bandwidth-intensive and remain the best justification for a broad development of the FTTH infrastructure for individual users.

For companies, sharing databases online is increasingly necessary for integrated production systems or complex business environments. Accessing a database located 1000 kilometres away is becoming as common as reading data from the local hard disk of a workstation. Already, in every economic sector, companies intensively using internet technologies are not satisfied with the performance of ADSL connections.

The first factor determining available bandwidth is the broadband technology used. Within each technology, other factors such as technology improvement, cable length, infrastructure saturation and environmental conditions have an impact on the available bandwidth. Most of these indicators are locally determined or vary in time, and thus are very difficult to measure. We define in this study a very simplified bandwidth model, by attributing to each broadband technology an "indicative bandwidth" that does not depend on the other factors mentioned above. In real use, the actual bandwidth may differ from the indicative bandwidth proposed here. This model is used to illustrate the impact of the technology mix on the average available bandwidth for the end user.

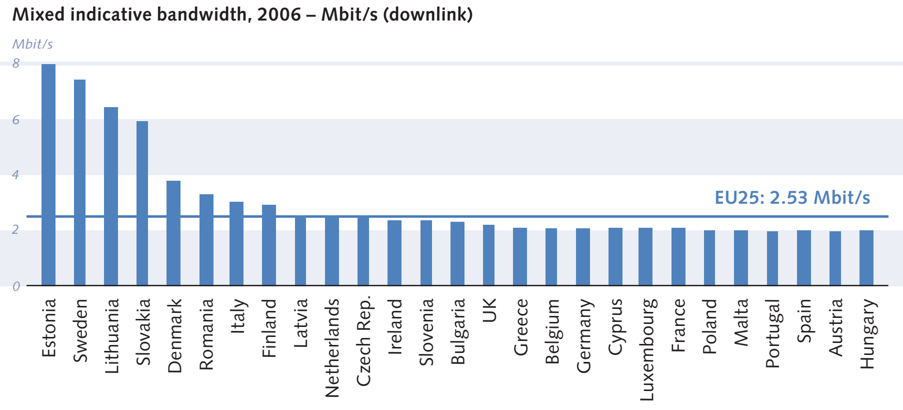
Table 2 – Indicative download bandwidth per technology

Indicative bandwidth per technology (downstream)	
ADSL	2 Mbit/s
VDSL	10 Mbit/s
FTTH/B	40 Mbit/s
Cable Modem	2 Mbit/s
Others	1 Mbit/s
Fixed Wireless	1 Mbit/s

By combining the indicative bandwidths in Table 2 with the respective market shares of broadband technologies in a country (see Figure 6), a country's broadband access can be characterized by a mixed indicative bandwidth (see Figure 7). One can distinguish:

- Countries with a developed optical fibre network able to deliver high bandwidth to many people. The average bandwidth in these countries will continue to grow over the next few years.
- Countries with low penetration and coverage limited to urban areas, where it is easier to deploy an optical fibre network. In this case, fibre connections (FTTH and FTTB) represent a higher proportion of the total connections, though the infrastructure development is still low. The average bandwidth in these countries will grow slowly, or may even diminish over the next few years while broadband coverage is developed in rural areas.
- Countries with a relatively low average bandwidth but good broadband coverage, now starting to develop VDSL and FTTH/B offerings, able to quickly improve their average indicative bandwidth.

Figure 7 – Mixed indicative bandwidth, 2006



Source Figure 7: Our calculations are based on "Broadband access in the EU: situation at 1 July 2007" (European Commission) [38]; IDATE

Composite indicator – Infrastructure

Based on the previous considerations, 13 key indicators have been chosen to construct a composite indicator able to characterize the broadband infrastructure development in the 27 member states. They have been grouped into four categories as follows:

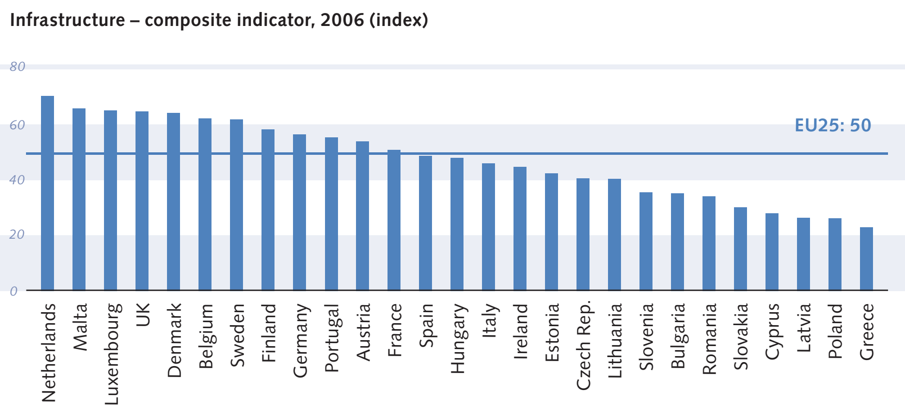
- Available broadband infrastructure
  - DSL coverage (Source: IDATE, Broadband Coverage 12/2005; IDATE, Benchmarking the Broadband Gap 5/2007)
  - Cable modem coverage (Source: Screen Digest – Cable Yearbook; IDATE, Broadband Coverage 12/2005)
  - UMTS coverage (Source: IDATE, Broadband Coverage 12/2005)
- Existing network infrastructure
  - Fixed-link telephone penetration (Source: ECTA – Broadband scorecard 2006)
  - Cable TV penetration (Source: Screen Digest – Cable Yearbook ; Dataxis 2004)
  - Average population per telephone exchange (Source: ECTA – Broadband scorecard 2006)
- Demand-side aspects
  - GDP per capita, purchasing power (Source: Eurostat)
  - Fixed broadband penetration (Source: Eurostat and IDATE)
  - UMTS penetration (Source: Mobile Communications)

- Other
  - Intermodal competition (our calculation: Herfindahl–Hirschman Index based on the different technologies' market shares)
  - Share of local-loop unbundling (ECTA – Broadband scorecard 2006)
  - Incumbent's market share (European Electronic Communications Regulation and Markets 2006 (12th Report), Volume 2)
  - DSL coverage in rural areas (Source: IDATE, Broadband Coverage 12/2005)

The resulting indicator (see Figure 8) can be used for comparison between countries or with a reference year. This indicator shows high disparities in the infrastructure availability across Europe:

- Nordic countries (Netherlands, Denmark, Sweden, Finland) score high in this indicator.
- Countries from Eastern Europe are late in the development of the broadband infrastructure. This lag is, in particular, due to a structural handicap: the telephone infrastructure, which is essential to the development of the ADSL infrastructure, does not reach almost every house, as it does in Western Europe. Wireless technologies should be expected to play an important role in the development of the internet infrastructure in these countries.

Figure 8 – Infrastructure, composite indicator 2006



The positions of the United Kingdom and Portugal are boosted by the high level of development of the cable modem and UMTS infrastructures in these countries.

2.1.2 Broadband readiness

The construction of a high-capacity infrastructure is not sufficient to make a population use broadband technologies. Many people with the possibility of using broadband simply lack the skills to take advantage of the technology, or do not realize the benefits that they could obtain by properly using the internet for personal use or at work.

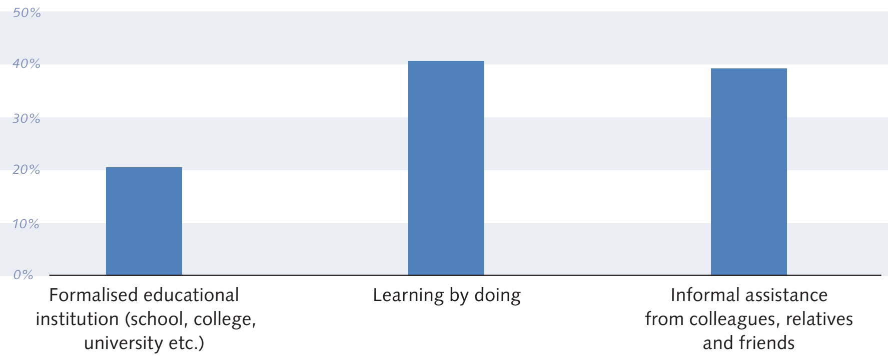
For our purpose of quantifying the impact of broadband on the economy, it was necessary to tackle the problem of broadband readiness: people's ability to adopt broadband at work is a decisive factor for the development of broadband-related business processes and structures.

IT skills diffusion

The internet and IT industry are places of constant innovation and evolution, where dynamic ways of acquiring skills are needed. Results from the "Community Survey on ICT use by individuals" (see Figure 9) show that:

Figure 9 – Ways to obtain IT skills

Percentage all individuals (EU25) who have obtained IT skills through:



- Formal learning or training sessions are far from being the most important way to obtain IT skills.
- Learning by doing is an essential way to develop one's IT skills. As a consequence, access to a personal computer at home is key to the development of IT skills. Most people make first contact with new technologies at work or at school, before they adopt them for personal use and then they further develop their skills. Broadband connections in large companies or universities are base points for the diffusion of broadband skills among employees and students.
- Most people develop their IT skills through contact with advanced users among their colleagues or relatives. The presence of an advanced user in one's daily environment, at work or in the family, acts as an enabler. Engineers, IT technicians and other computer enthusiasts are able to stimulate computer use and spread their skills: the presence of science and technology professionals among a population is a catalyst for the diffusion of broadband use.

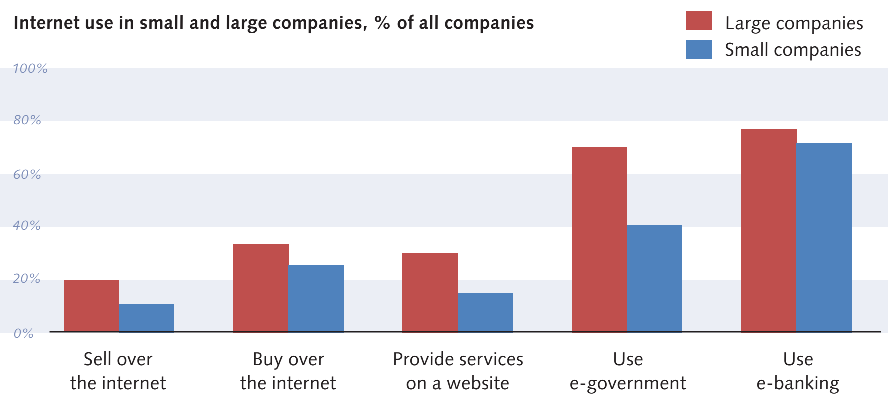
Source Figure 9 and 10: Eurostat – Community Survey on ICT use by individuals, 2006

Adoption barriers are higher in small companies

Adoption barriers in big and small companies: the importance of IT awareness

Figure 10 – Internet use in small and large companies

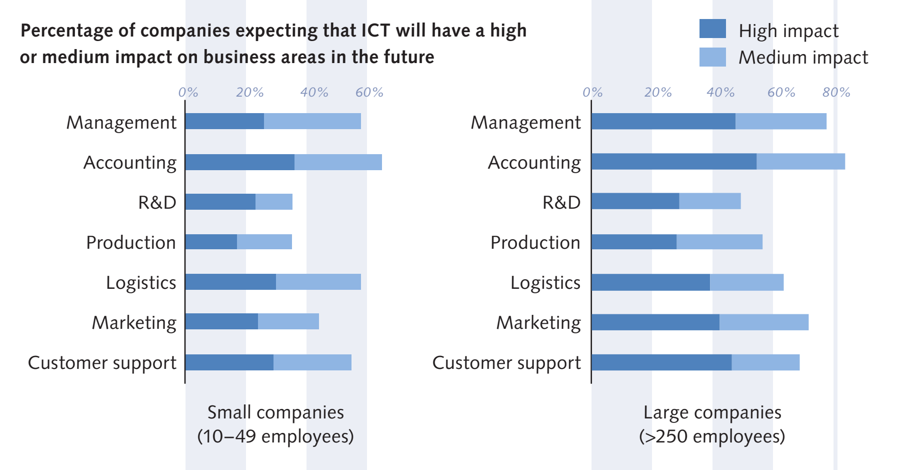
Internet use in small and large companies, % of all companies



Business models using broadband technologies enable cost sharing between several small companies to achieve economies of scale. As a result, investments in internet technologies are scalable and benefit both small and large companies. From the point of view of the technology, there should be no difference in internet use by small or large companies (see Section 4.4.2, the role of the size of the company). The results in Figure 10 and Figure 11 show that small companies use far fewer of the internet's possibilities than large ones. Barriers to using the internet in small companies are greater than in large companies.

In contrast to large firms, many small businesses are not aware of the benefits of developing their business over the internet. Once they learn about and take advantage of broadband technologies, a very large majority of them consider that the impact on their business is positive. In a survey made among small and micro companies using broadband in Cornwall (UK) [76], 91% of them consider that the internet has had a positive impact on the performance of their business.

Figure 11 – Expected impact of ICT in small and large companies



Source Figure 11: e-business-w@tch, 2006 [25]

Further development of the infrastructure would not necessarily have a decisive impact on this lack of awareness: communication campaigns and further involvement of professional organizations in the development of internet use among companies are a more successful way to increase broadband readiness.

Composite indicator – Broadband readiness

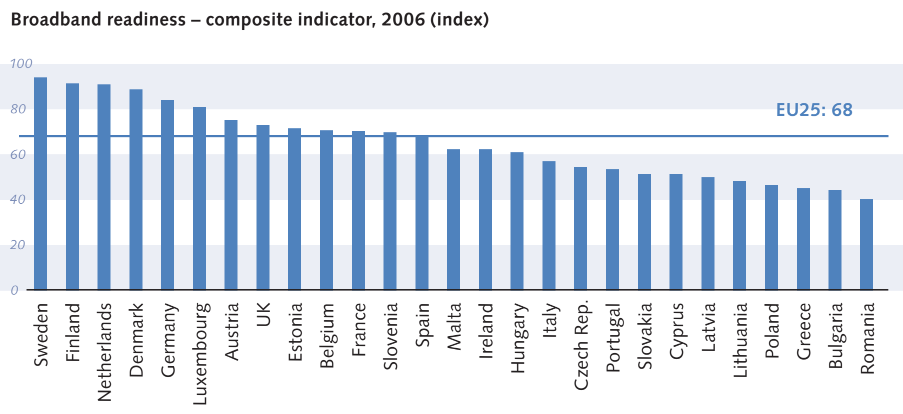
Based on the previous considerations, seven key indicators have been chosen to construct a composite indicator able to characterize broadband readiness in the 27 member states. They have been grouped into four categories as follows:

- Access to a personal computer
  - Computer penetration in households (Source: Eurostat: Community survey on ICT use in households, 2006)
- Technical competencies
  - IT skills (high level) (Source: Eurostat: Indicators of the knowledge society, 2006)
  - Human resources in science and technology (Source: Eurostat: Handbook on science, technology and innovation, 2007) [52]
- Early access points
  - Broadband access in large enterprises (Source: Eurostat: Community survey on ICT use in enterprises, 2006)
  - Broadband access in schools (Source: European commission: Benchmarking access and use of ICT in schools, 2006) [35]
- Innovation
  - Research and development expenditure (Source: Eurostat)
  - Innovation expenditure in SMBs (Source : Eurostat: CIS4)

The resulting composite indicator (see Figure 12) is relative to the readiness of the population in European countries to take advantage of the potential of the internet. It can be used for comparison between countries or with a reference year:

- As with the infrastructure indicator in Section 2.1.1, the Nordic countries are significantly more advanced in the diffusion of skills related to new technologies among the population.
- Even though the gap between the most advanced European countries and the least developed ones seems to be high, all European countries have the potential to develop rapidly into a knowledge society. The proportion of technicians and scientists among the population of the countries which appear here at the bottom of the list is promising for a rapid development, relative to other developing regions of the world.
- A few countries score surprisingly high on this indicator, in particular Estonia, Slovenia and Hungary, thanks to their high proportion of human resources in science and technology in the overall employed population and high proportion of schools connected to internet.

Figure 12 – Broadband readiness, composite indicator, 2006



2.1.3 Use of online services

Productivity improvements depend on the actual use of the internet

People and companies with a broadband connection may make little use of the possibilities of broadband technology. In order to quantify the impact of broadband, it is necessary to take into account the actual use of it.

Many indicators of the use of online services are provided by Eurostat's community survey on ICT use in companies, in households and by individuals. This is a very large survey on a sample of about 150,000 companies across Europe [51]. The results are available by economic sector, by country, and by region in the 2006 version of the survey. The survey questionnaire has been improved since its first version in 2002, while preserving continuity in the series as much as possible. This enables tracking of the adoption of online services in most European countries over time, in particular between 2004 and 2006.

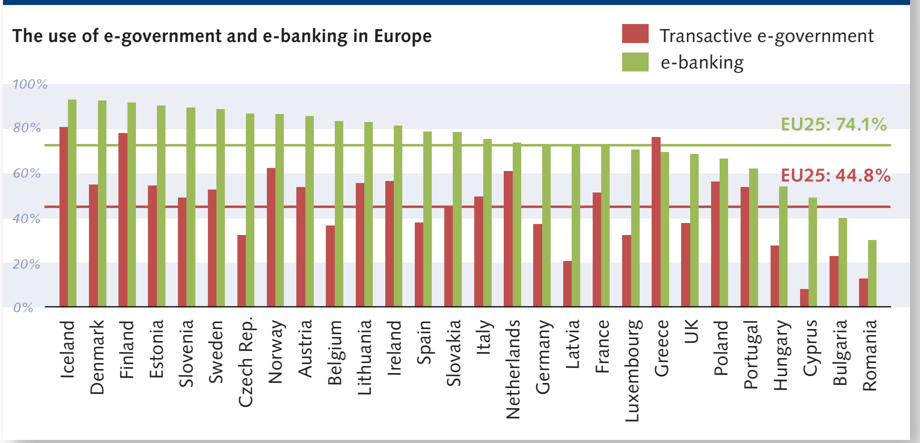
The most used form of e-business in Europe is online banking (74% of the companies), followed by the use of a company website (62%, half of which provide after-sales support) and transactive e-government (45%). 26% of European companies buy over the internet, while 12% sell goods and services online. 14% have linked their IT system to those of their customers or providers (Source: Eurostat: Community survey on ICT use in enterprises).

E-government and e-banking

Most European companies use e-banking and e-government

The internet is used by most European companies to exchange information with their bank. This is due, in particular, to the banks' ability to use information technologies internally and provide secure, easy-to-use e-banking websites to their customers. For simple applications, e-banking can be used over narrow-band internet. As the services provided online by banks increases, narrow-band connections tend to be insufficient. Integration of a company's processes with the bank's information system, such as a secure electronic payment device at a shop's checkout, requires an always-on connection between the bank and its customer, thus making broadband availability an essential advantage.

Figure 13 – The use of e-government and e-banking in Europe



In Figure 13, "transactive e-government" means returning completed forms over the internet. According to the report "Online availability of public services" (2006) [13], Spain is one of the most advanced countries in providing public services online for businesses. However, fewer than 40% of Spanish companies use the internet for returning completed forms to public services. Obviously, making public services available online is not necessarily directly linked with their use.

Source Figure 13 and 14: Eurostat – Community survey on ICT use in enterprises

E-commerce

Companies use the internet to find information about providers more easily and to buy online certain kinds of goods.

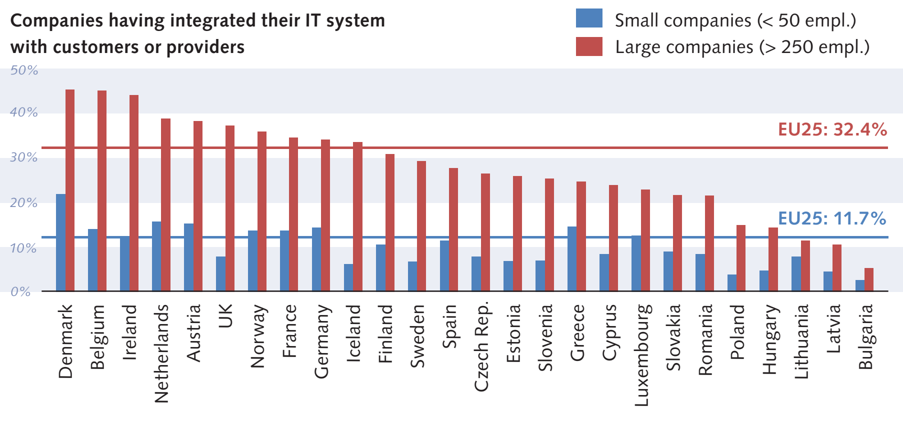
Figure 14 – The use of e-commerce B2B

Buying and selling online (see Figure 14) does not only occur over a website or an online shop: for regular customer–supplier relations, orders are directly transferred over the internet from the customer's IT system to the supplier's IT system. These technologies are described in more detail in Section 4.4.

Electronic link with customers and providers

Links between companies' IT systems allow the transfer of orders and invoices. It can also be developed further, into a more complete sharing of information about stocks, processes, research and developments, planning or sales.

Figure 15 – Electronic links between companies

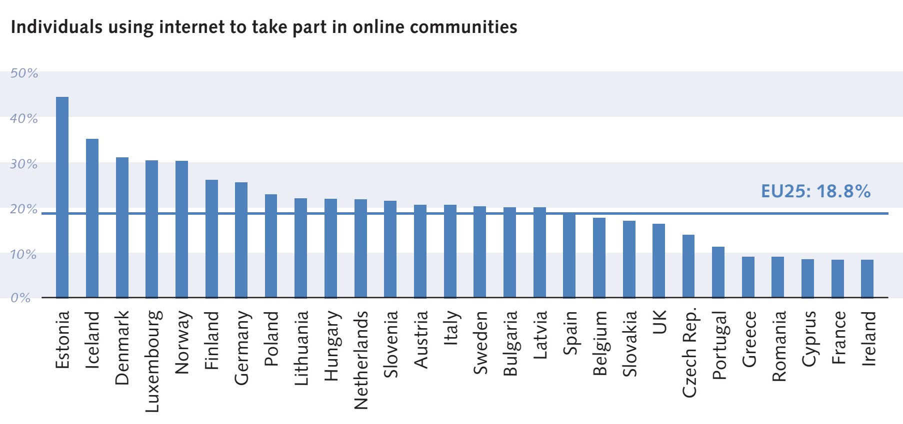


There are important disparities in the use of integrated IT systems from one economic sector to another. Small companies are also later to use integrated IT systems (see Figure 15). These issues are further developed in Section 4.4.

Use of online communities by individuals

The use of online communities by individuals also has an impact on the activity of companies: employees using such technologies in their private life also use them at work, for example to take part in research communities, exchange information with professionals in other companies or contact customers in online communities.

Figure 16 – Online communities: chats, newsgroups, forums



Source Figure 15 and 16: Eurostat – Community survey on ICT use in enterprises

The use of the internet to take part in online communities is not reserved to the most advanced knowledge societies. Statistics from the "Community survey on ICT use by individuals" (see Figure 16) and from major community websites confirm that the usage rate of these online technologies is high in some central and eastern European countries.

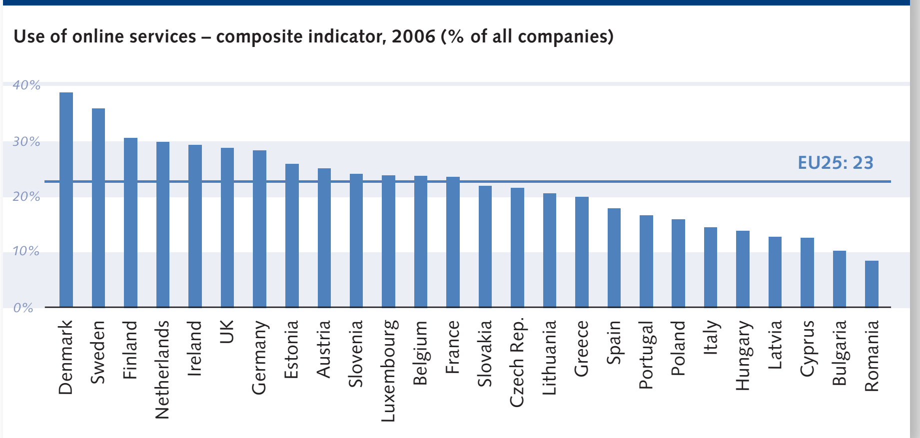
Where no measure of the use of such technologies by companies is available, their use by individuals is used as a proxy indicator. Proxy indicators are strongly coherent with the other indicators used for the construction of the composite indicator.

Composite indicator – Use of online services

Based on the previous considerations, 14 key indicators have been chosen to construct a composite indicator able to characterize the use of online services in the 27 member states. All indicators are gleaned from the "Community survey on ICT use in enterprises" and the "Community survey on ICT use in households and by individuals". They have been grouped into four categories as follows:

- Online services through a website (% companies)
  - Companies using the internet for banking and financial services (as a customer)
  - Companies using the internet for interaction with public authorities – for returning completed forms
  - Companies using online after-sales services
  - Companies providing online after-sales services
- E-commerce (% companies)
  - Companies having placed more than 1% of their orders over the internet in the last calendar year
  - Companies having made more than 1% of their sales over the internet in the last calendar year
  - Companies purchasing over electronic networks
  - Companies selling over electronic networks
- Interconnected IT systems (% companies)
  - Companies having employees who connect to IT systems from remote locations through electronic networks
  - Companies having IT systems for orders and purchases which link to IT systems of suppliers or customers outside the enterprise group
- Emerging internet technologies
  - Telephone, videoconferencing (% individuals)
  - Web radio, web TV (% individuals)
  - Chat, newsgroups, forums (% individuals)
  - Companies having employees who connect to the company's IT system during business travel (% companies)

Figure 17 – Use of online services, composite indicator, 2006



The resulting composite indicator can be detailed by member state, size of the company or economic sector, and calculated over the period 2003–2006 with the available data from Eurostat. It is expressed as a percentage of companies.

The results of this composite indicator (see Figure 17) show that the use of online services is not directly correlated to the infrastructure development, as countries scoring high here, such as Estonia, Slovenia and Ireland, appeared in the lower half of the infrastructure benchmark.

The deviation of the indicator is very high. In the first step of internet development, only the large companies in a country integrate online services into their processes: they represent a very small percentage of all companies. In a further step of internet development, medium and small companies also develop online services, thus dramatically raising the percentage of companies using these technologies.

2.2 Analysis of broadband development in Europe

The indicators defined above allow several groups of countries having a similar broadband development pattern to be distinguished.

2.2.1 Geographical disparities in broadband adoption across Europe

The previous indicators and sub-indicators already indicate that some countries can be grouped together:

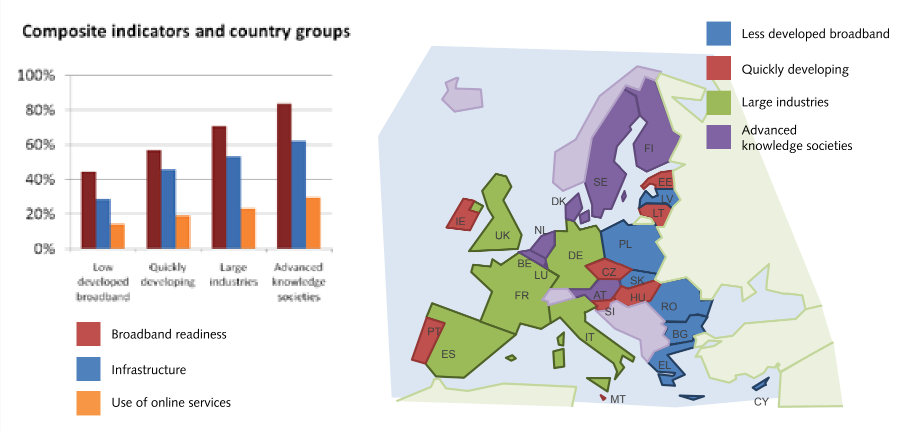
- The Nordic countries consistently rank at the top of each indicator.
- Some of the central and eastern European countries rank low on all three indicators.
- The five largest European countries (Germany, France, UK, Italy and Spain) face problems of inertia due to their vast territory and correspondingly complex telecommunications infrastructure. Within each of these countries, important socio-economic disparities raise problems of e-inclusion and diffusion of internet technologies at all levels of the economy and public services.
- Other countries seem to be more difficult to classify, as they have some characteristics of both the advanced and the less advanced knowledge societies; in particular, they have a relatively under-developed infrastructure but a high usage rate of online services.

Grouping countries together does not aim to define structural sub-regions in the European Union. The distinctions between country groups are permeable: they may change in time and depend on the way the performance of each country is measured. Making distinctions between European regions allows better to analyze broadband development and the dynamics of the broadband-related economy within Europe in order to establish policy recommendations better adapted to the diversity of the European Union.

Ward linkage algorithm

A statistical method commonly used to group similar entities is the analysis of the “distance” between each of these points in an imaginary space defined by their characteristics. There are several algorithms available to make this kind of hierarchical cluster analysis. Here, we used the Ward linkage algorithm, with a set of five characteristics: the three composite indicators defined in Section 2.1, the population of each country and its GDP per capita. All indicators used were normalized to fit in a scale between 0 and 1. No weighting of the indicators is used in a cluster analysis.

Figure 18 – Composite indicators and country groups



The algorithm proposed two, three, four or nine groups of countries. We chose to use four groups of countries, as it is the level of detail most suitable for the analysis of broadband. The four groups of countries (see Figure 18) found by the Ward linkage algorithm correspond to the groups qualitatively described at the beginning of this section:

- Austria, Belgium, Denmark, Finland, Luxembourg, the Netherlands and Sweden: these countries are the most advanced knowledge societies and have already achieved a high level of broadband development and use. They also tend to have a very high GDP per capita.
- France, Germany, Italy, Spain and the United Kingdom: this is the smallest group when considering the number of countries, but represents 73% of the European GDP and 62% of its population. These large industrial countries have large production systems and markets, but are confronted with the difficulty of developing broadband over vast territories and among large populations.
- Ireland, Czech Republic, Estonia, Hungary, Malta, Lithuania, Portugal and Slovenia: most of these countries have a relatively low GDP per capita (with the exception of Ireland). They are engaged in a modernization of their economy mostly based on high-value-added activity: they have quickly developed the adoption of internet in their societies and have reached a level of broadband development close to that in the largest European countries.
- Bulgaria, Greece, Cyprus, Latvia, Poland, Romania and Slovakia: these countries are late in the development of the knowledge society because of historical and structural disadvantages. Low labour costs in these countries drive foreign investments necessary to the modernization of the production system and increase the competitiveness of the European economy.

2.2.2 Factors driving the adoption of online services

Broadband and narrow-band online services

About 10% of the companies using online services do not have a broadband connection (our calculation based on the “Community survey on ICT use in enterprises”): they use dial-up modems on the analogue telephone infrastructure or ISDN, the first generation of digital connection over the telephone infrastructure.

With the exception of real-time media streaming of audio or video content, all broadband applications can be run on narrow-band: it is only a matter of price and ease of use. Shopping online, downloading huge files, sending e-mails with heavy attachments or playing online multiplayer games is theoretically possible with a dial-up modem, though it rapidly becomes uncomfortable and a disappointing experience for the user.

The distinction between narrow-band and broadband applications is a matter of intensity of use.

The relation between broadband connectivity and the intensity of internet usage has been assessed by several studies:

- "Broadband adoption and content consumption" by Hitt and Tambe (2007) [68] used a dataset raised in 2002 and 2004 among 8400 individuals in the USA, and established that broadband adoption increased the time spent online by an average of more than 21 hours per month.
- The behavioural analysis from the Online Publishers Association and comScore networks [99] is based on a cross-section of more than 1.5 million users worldwide: broadband users spend on average about 40% more time on the internet than dial-up users.
- The PEW project [69] showed that 43% of broadband users in the USA used the internet to get information on a typical day, while 23% of dial-up users did so.

In companies, although broadband is not required for some simple forms of e-banking, e-government, online purchases and e-mails, it becomes quickly an important advantage when trying to integrate the internet into the company's processes such as accounting, procurement or customer relations. In all economic sectors, a company willing to take advantage of online technologies to develop its business cannot be satisfied with narrow-band connectivity. In many cases, even ADSL connections with more than 1 Mbit/s download rate are insufficient. For example, the five companies that were analyzed for the case study in Cornwall (see Section 3.2) have access to the internet through ADSL and are looking forward to further developing their online activities when connected with faster internet access. None of them has more than 25 employees and only one is an IT service provider.

Broadband becomes quickly an advantage when trying to integrate the internet into a company's processes

Companies having no access to broadband internet are not encouraged to develop online services or to use the internet to integrate their processes with the processes of their customers, suppliers or service providers. Businesses using narrow-band internet are either not in a broadband coverage zone or are not aware of the benefits that the internet can bring to improve their productivity, provide new services and expand their business. Consequently, the impact of narrow-band internet on the economy is very limited.

Broadband is essential for internet-related growth

Infrastructure development compared to broadband readiness

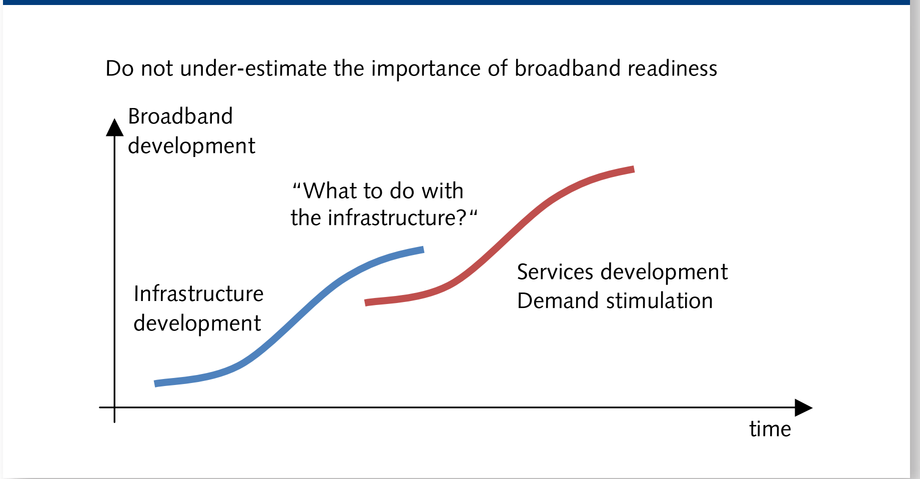
Most of the broadband strategies so far have been aimed at infrastructure development, in particular to increase broadband coverage in remote areas. Completed projects notice that, in many cases, the use of the infrastructure is not as high as expected. Additional projects or initiatives are required to stimulate individuals and companies to use broadband internet. As a result, broadband development lacks social and economic impact and investments are not as beneficial as expected. Experience shows that demand stimulation should be planned much earlier in broadband projects and financing.

Successful broadband strategies focus on the development of the infrastructure and the use of online services

The three broadband composite indicators enable an analysis of the effect of infrastructure development and broadband readiness improvement on the adoption of online services. This analysis has been conducted concerning the evolution of the three indicators in the 27 European member states surveyed in the community surveys on ICT use, between 2003 and 2006.

After removing the missing values, 88 values could be used for the analysis. In order to remove country-dependent effects, the evolution of the use of online services relative to the infrastructure development and broadband readiness is considered separately for each country. Only the evolution of the indicators year on year is considered in the statistical analysis.

Figure 19 – Broadband readiness is as important as infrastructure development



This analysis can be interpreted as a measure of the causal influence of the development of the infrastructure and broadband readiness on the use of online services, under the following hypothesis: the feedback effects of an increased use of online services on the readiness and infrastructure are ignored, as being far less important than the direct effects (broadband readiness and infrastructure development having an impact on the use of services).

Results of the analysis (see Figure 19):

- The constant term □ is null: the use of online services does not increase without an improvement in the two other factors. This result was expected: it is reassuring about the quality of the model.
- The infrastructure parameter □ is the highest: 66% of the adoption of online services is due to the development of the infrastructure. This result was also expected, as the broadband infrastructure is a prerequisite for the development of broadband services.
- The readiness parameter □ is still far from negligible: 34% of the adoption of online services is related to an increase in broadband readiness.

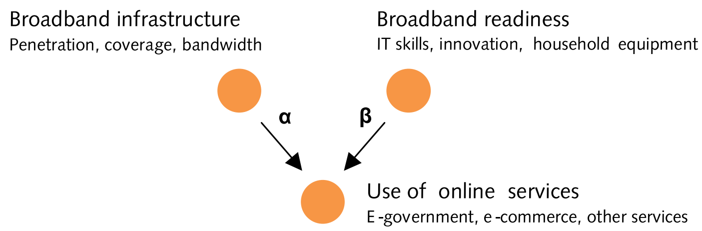
Both □ and □ are considered highly significant by the statistical analysis.

The respective values of □ and □ tend to indicate that broadband readiness, or demand stimulation, should be granted more attention in the development of broadband than it has received until now.

Demand stimulation campaigns may include:

- broadband demonstration campaigns in social events and professional organizations
- internet access in schools and public libraries; the presence of IT equipment and professionals specially trained to support individuals in their use of the internet; organization of public internet events
- involvement of the population, in particular young and elderly people together, in multimedia projects
- involvement of professional organizations, such as Chambers of Commerce, to promote the use of internet technologies in small and medium companies.

Figure 20 – Analysis of the indicators



$$\Delta \text{Use of online services} = \alpha \cdot \Delta \text{Infrastructure} + \beta \cdot \Delta \text{Readiness} + \gamma$$

Δ stands for "variation over time". α, β and γ are three parameters.

3 Broadband adoption in two regional cases

In order to describe the development of broadband and its key impacts in a specific context, two regions have been selected as case studies: projects in Cornwall (UK) and Piedmont (Italy) demonstrate how broadband was successfully made available throughout an entire region and how the availability of broadband can change economic prospects and social life in the region.

The case studies serve as an illustration of the sustainable economic and regional effects that broadband can trigger and support. Moreover, certain patterns of the impact of broadband on growth that are described in a more analytical way in subsequent chapters can be recognized in the case studies.

3.1 Methodology

The two regional case studies were selected among the 50 regional broadband projects invited by the European Commission to participate in the conference "Bridging the Broadband Gap" in May 2007. These projects were analyzed on the basis of documentation that they presented at the conference and discussions with the representatives of the projects. The following criteria were used to select suitable case studies:

- Focus on broadband services and infrastructure: both approaches are important to a successful regional broadband project. However, the economic impact of broadband depends more directly on the use of broadband services. Only regional projects focussing on both the building of a broadband infrastructure and the use of broadband services were selected.

- Use of the online services by businesses and individuals: the use of the internet by individuals is very important to the development of the knowledge society, though economic impacts such as employment and production growth can only by analyzed on the basis of the firms' activity.
- Availability of quantitative results: such results are needed to evaluate the quantitative impact of broadband on the regional economy. Very recent projects with no observable results and projects without a comprehensive evaluation framework could not be selected.

In order to complete the information already available, questionnaires were sent by e-mail to 26 projects throughout Europe. The projects were informed about the intention to possibly include their project in this study and were screened for information which would be required for an analysis of the regional impact of broadband.

Experience gained from the two case studies are complementary

In the end, two cases were selected where broadband has been deployed and put into effect successfully, namely, actnow Broadband Cornwall from the UK (www.actnowcornwall.co.uk) and Wireless Piemonte Regional Broadband Network (WI-PIE, www.wi-pie.eu) from Italy. The cases differ, particularly in size (population and territory) and composition of industrial sectors. Experience gained from the projects are, thus, complementary. Together, they cover a range of topics that are discussed throughout the study.

Compare before and after broadband development

In each of the case studies, the present situation in a region is compared to the past when broadband was unavailable. Instead of benchmarking similar cases against each other, it seemed to be more promising to select contrasting cases that focus on different aspects related to broadband. In so doing, a wider range of aspects could be examined and described.

The approach to describing the impact of broadband on the regional economy is two-fold:

- We have collected primary data on a micro-economic level so that benefits of broadband can be analyzed for selected companies.
- Regional macroeconomic data is taken into account for the analysis. We consider selected data that well describe the development of the economy.

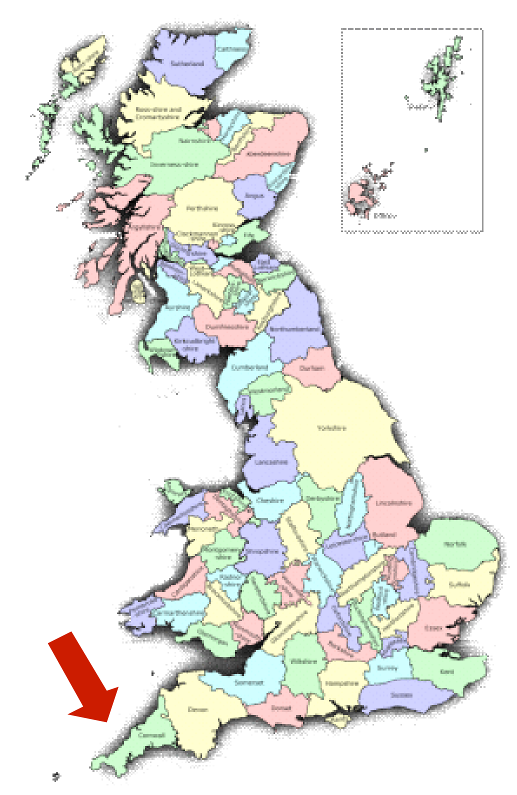
Individuals, public organizations and private organizations are potential beneficiaries of a broadband connection. However, the case studies mainly focus on the benefits that the use of broadband may have for companies and, in consequence, for economic productivity and growth .

3.2 Cornwall, UK: an Objective One region with little developed industry

3.2.1 Overview

Cornwall is a rural region in the far South West of the United Kingdom (see Figure 21 and Figure 22). Former industrial activities concentrated on mining (especially tin and copper). The decline of the mining industry left the region poor and basically without prospects for young people. Brain drain and unemployment resulted as pressing issues. Cornwall's remoteness from the main population centres of the UK additionally hampered economic activity.

Figure 21 – Location of Cornwall in the UK



Source Figure 21: www.abcounties.co.uk/counties/map.htm (adapted)

As a consequence, Cornwall increasingly tried to capitalize on its scenery and tourism became a major economic factor.

Despite such efforts, economic indicators for Cornwall have been disappointing over a long period. With only 65% of the UK average, Cornwall was the county with the lowest Gross Value Added (GVA) per head in the UK in 2005 (Source: Office for National Statistics, 2007).

The wage level was significantly lower than the national level: gross earnings in Cornwall were 20.9% below the national level in 2005 ([88], p. 7). The low wage level can partly be explained by relatively high numbers of part-time workers and self-employed people: in 2005, 40% of all employees worked part-time in Cornwall (as compared to 26% at a national level) and 23% of the total labour force (12.8% at a national level) was self-employed ([90], p. 7).

The Gross Domestic Product (GDP) per head of Cornwall and the Isles of Scilly (see Table 3) only reached 76% of that of the EU25 in 2004 (Eurostat/Local Intelligence Network Cornwall 2007 [53]). In 2006–2007, the GDP of Cornwall per head was about € 18,600. For comparison, in 2006, the GDP of Greece per head was € 17,500 and that of the UK was € 31,500.[2] Obviously, the economic power of Cornwall was closer to that of Greece than the UK.

Area (1)	3563 km²
Population (2006) (1)	517,400 inhabitants
GDP (2006) (1)	€ 9634 million
Number of businesses (2004) (1)	20,564, of which 84% are micro-companies and 12% are small companies
% in employment who are self-employed (2005) (2)	23% (UK: 12.8%)
Cornish economy	Retail and tourism sector, under-developed manufacturing sector, agriculture, real estate

Table 3 – Fact sheet for Cornwall, UK Sources: (1) actnow, (2) LINC/ Nankivell ([90], p. 35)

[2] Based on figures from Eurostat 2007.

Figure 22 – Map of Cornwall

Source Figure 22: Courtesy of VisitCornwall

As a laggard region, Cornwall qualified for the Objective One programme of the EU which was set up in 2000 to reduce differences in social and economic conditions within the EU.[3] Cornwall received financial support from the EU and the UK.

One of the projects financed with the help of Objective One is the project "actnow". Actnow early recognized the importance of ICT, and thus of broadband, for transforming businesses and developing the region. The main objective of this project was to increase the investment level in Cornwall by creating a broadband infrastructure and promoting the use of broadband among local businesses. In particular, actnow provided consulting and financial support for small businesses to benefit from broadband. Small businesses could get access to EU funding through the actnow initiative. It was the first public–private-partnership in the UK which aimed to provide broadband access and to support local businesses in making effective use of it.

The project started in April 2002, with overall costs of about € 20 million, including € 7.5 million from the Objective One programme, € 4.5 million from British Telecom, € 1.5 million from the South West of England Regional Development Agency and € 6 million spent by businesses.

Very ambitious targets

At the beginning of the project, actnow was assigned quantitative objectives: within the first three years, actnow was supposed to achieve a coverage rate of 50% and a broadband penetration of 3300 businesses (equivalent to about 18% of all businesses). In comparison, an earlier development of the DSL infrastructure in a rural region in Wales had only reached 3% broadband penetration among businesses 1.5 years after its launch.

Actnow proved very successful in reaching its initial targets: a coverage rate of 99% was achieved within the first four years and the challenging target of 3300 businesses using broadband connections was reached in April 2004, a whole year ahead of time. In 2007, more than 9000 businesses have been assisted to connect to broadband in Cornwall by actnow, i.e., around 50% of all Cornish businesses.

Section 3.2.3 takes a closer look at the underlying reasons for this success and analyze the effects the project has generated.

[3] The Objective One programme started in 2000 and ends in 2008. It will be followed by the Convergence programme (planned for 2008–13).

3.2.2 Initial situation

Lack of broadband infrastructure and undeveloped readiness

In 2002, there was virtually no broadband coverage in Cornwall. Broadband was available to only 2% of households. Moreover, businesses and especially small businesses lacked an awareness of the potentials of broadband. Since 96% of Cornish businesses are small or even micro-sized, awareness of the need for broadband was very low among local businesses. Actnow thus had to face two essential problems: a rudimentary broadband infrastructure and an undeveloped readiness for broadband usage.

A cautious infrastructure development plan

There are 100 phone exchanges in Cornwall. Since a low penetration rate, such as that in Wales, would not have ensured a positive return on the initial investment, BT, the telecommunications operator, cautiously planned to upgrade at first four and then 12 phone exchanges and wait to see whether penetration targets were met. Actnow would be responsible for stimulating demand to ensure additional investment in new exchanges as BT, the operator, would only invest in the infrastructure if demand was high enough. Accordingly, only those areas with the highest population density were to be equipped with ADSL technology in the beginning.

As well as the investment in infrastructure and communication campaigns, actnow and BT provided companies with a ready-to-use broadband package, in the form of a bundled IT solution including hardware, software and broadband connectivity at a heavily subsidized price. This standard solution, however, did not meet success among the target group: individual advice proved to be better adapted to the needs of the companies and became the focal point of the strategy of actnow.

3.2.3 Actnow strategy: investing in demand stimulation

Figure 23 – The actnow marketing campaign

Source Figure 23: actnow

From the outset, actnow has combined the development of a broadband infrastructure with an extensive marketing campaign to raise awareness among local businesses. Actnow identified demand stimulation and education as the key success factors for broadband take-up.

The actnow marketing campaign was the largest business sector campaign in Cornwall and quickly made actnow well known across Cornwall. The actnow team was present at trade shows and various other events, e.g., of business associations, to spread information about broadband and talk to local businesses. Due to lack of advertising facilities, vans with actnow posters went around towns and industrial sites at crucial times and places (e.g., business exhibitions). Actnow made use of above-the-line marketing (press, radio, posters; see Figure 23) and direct marketing (phone, e-mail) to communicate directly with early adopters. Best practices were essential in helping to explain the benefits of broadband.

Live demonstrations were organized so that people could better understand why they would need broadband. For this purpose, actnow equipped a Land Rover with a satellite connection (backbone) (see Figure 24) and an embedded Wi-fi

Figure 24 – The actnow Land Rover as mobile hotspot

Figure 25 – Exchange Trigger Point Percentage registered so far (14.05.2003)

Below is a list of Cornish telephone exchanges that have been earmarked for possible broadband upgrades. The trigger point is the number of people who must register their interest before their exchange will be broadband enabled. The percentage so far shows the percentage of pre-registration already achieved.

Par	300	79%	St Day	350	31%	Germoe	350	21%
Wadebridge	300	77%	St Just	350	31%	St Columb	350	22%
Hayle	400	74%	Stenalees	350	26%	St Dominick	400	18%
Devoran	350	66%	Portreath	350	23%	Lostwithiel	350	19%
Nanpean	250	43%	St Agnes	350	23%	Mevagissey	350	18%
Callington	350	36%	Three Waters	250	24%			

hotspot: "You just park it outside, walk around with a laptop, and show how it works!"

Apart from this top-down campaign, grass-root commitment played a crucial role in spreading broadband in Cornwall and was also supported by actnow. The protest of an individual whose town was initially not considered for a broadband upgrade prompted the telecommunications provider to set a "trigger level" for the town, i.e., to name the minimum number of subscriptions required for the exchange to be upgraded (see Figure 25). Despite high minimum subscription numbers, this model proved successful because such trigger levels became a great incentive for local people (especially early adopters aware of the benefits of broadband) to convince businesses and individuals in their local community to register. In this way, viral marketing led to unexpectedly fast development of the infrastructure, even in very rural areas.

Acting as a coach and intermediary

Source Figure 24: actnow
Source Figure 25: Objective One Media Releases, Cornwall and the Isles of Scilly

Another part of actnow's strategy was to engage in a dialogue with companies in order to identify problems and provide them with direct help, and to give them personal advice on how they could develop their use of the internet. It crucially lowered the barrier, especially for smaller companies, to subscribing to broadband services and applying for subsidies to make further ICT investments under the actnow accelerator scheme.

For small businesses, contacting the service provider for technical support can be tedious and time-consuming. For instance, in an early stage of broadband roll out, many companies could not correctly connect to the internet due to a series of poor quality modems provided by the telecommunications operator. As an intermediary between the internet provider, BT, and the internet users, actnow provided service and technical expertise to help businesses troubleshoot their connection.

Tailored solutions

Once connected, dedicated business advisors would provide ICT advice to ensure the businesses could get the most out of their connection and plan additional strategic ICT investments. Individual advice could take into consideration of the particular needs of a business and design a broadband strategy tailored to its needs. In total, 3700 businesses have received ICT-related advice at their premises from an actnow advisor.

Applications for EU funding are heavy administrative constraints, which appeared to be a major barrier for small companies needing financial support. Actnow provided administrative services as an interface between applicants and the funding authority, to facilitate access to the EU financing programme for micro-businesses with a good ICT investment proposal.

Actnow did not directly organize IT training but companies who received support from actnow could participate in training sessions organized by "Let's do IT", a sister project of actnow, funded by the European Social Fund, which was focused on skill development. These sessions were designed to foster autonomy, competence sharing and "learning by doing" among the participants, with the support of an IT professional. However, less than 10% of the companies went through such an education.

Actnow's advisers were directly in contact with companies during the project. They identified the lack of broadband awareness as a major barrier to the adoption of broadband by companies. By providing companies with concrete solutions and advice adapted to their activities, the advisers could make the companies aware of the benefits of broadband and overcome this barrier, regardless of the level of IT skills in the company. As underlined in Section 2.1.2, contact with an IT professional is a crucial factor for broadband readiness. In the case of Cornwall, this contact has had more impact than improving IT skills through dedicated training sessions. This success is mostly due to actnow proactively coming into contact with companies, through dedicated advisers and strong communication campaigns.

Increasing the IT investment level

During the first years of the project, actnow set an incentive for early adopters of broadband: it provided small businesses not only with advice but also with subsidies of up to 40% of their IT equipment (hardware, software, broadband connection). In 2000, IT investments of local businesses were very low: about € 430 (£300) per year on average including the telephone bill. In 2003, this amount increased to € 2160 (£1500) per year and, in 2006, average spending on IT was about € 7200 (£5000) per year for those participating in the actnow accelerator scheme.

Figure 26 – "It's so much easier when you shop from home", supermarket sign in Camborne, Cornwall

The demand for broadband is higher in remote places

The remote location of Cornwall and especially the Isles of Scilly also contributed to a strong demand for broadband connections. For example, mail-order shops offer a wider range of products than shops in isolated areas (see Figure 26). People living in such places are more willing to shop via the internet and can use broadband as a link to the rest of the world.

As a result of the measures taken, the take-up curve achieved was so remarkable that the original plan of a very slow broadband rollout was abandoned (see Table 4). One year after the launch of the project, there were already 5300 broadband subscribers in Cornwall. The broadband penetration among SMEs in Cornwall was 47% in 2006, four years after the launch of the project.[4]

Make people "ready" for using broadband

The case of actnow illustrates the fact that effective use of broadband services is not achieved simply by the rollout of a broadband infrastructure: it has to be complemented by making people "ready" for using broadband. The role of actnow as a direct contact for small companies played an essential role. To a great extent, the success of the project was due to marketing, i.e., to demand stimulation and demand creation. The strong emphasis on demand reflects the importance of the broadband readiness factor for the use of broadband services.

Table 4 – Rollout of broadband in Cornwall
Sources: (1) actnow, (2) actnow in LINC ([85] p. 19f)

	2002	2006
ADSL coverage [(1)]	2%	99%
SME penetration in Cornwall [(1), (2)]	<1%	47%
No. of businesses connected [(2)] (including those not registered with actnow)	--	8528 (around 9000)
IT spending of companies [(1)]	€ 2160/year (2003)	€ 7200/year
Total no. of connections [(2)]	--	96,000

3.2.4 Prospects for the future

Actnow is well aware of the fact that further development to the "next generation" of broadband has to be made, so that Cornish businesses can continue to take full advantage of the potential of the internet. The current objective of the project is to reach 100% penetration among small businesses.

Supporting strategies

A "killer" application of broadband for small businesses: flexible working

Actnow launched the actnow flex project in 2006 to bring the benefits of flexible working to small and medium sized businesses. Flexible working makes it possible for employees to work from anywhere using the telecommunications infrastructure, not only at their workplace: at home, during travel, or on the road between visits to clients. The aim of the project is to work closely with businesses to help them introduce flexible working practices and to monitor what impact this has on business productivity, employee work–life balance and reductions in travel.

The project, which will conclude in June 2008, has also developed a popular toolkit to help businesses along the way to adopting flexible working practices. The toolkit addresses

[4] This figure cannot be compared with data from the community survey on ICT usage since companies with fewer than 10 employees are not systematically included in Eurostat's survey [51].

issues such as management of flexible workers, health and safety, technology, legal matters and taxation (www.flexible-working.org).

A rural knowledge economy

Actnow believes that Cornwall's unique environment and desire to build a rural knowledge economy make it ideally suited for flexible workers, and they aim to become what they call "the flexible working capital of the UK".

Actnow believes that Cornwall needs to develop an information society, in which the benefits of broadband can be enjoyed by all members of society, if it is to build a knowledge economy in a rural area. The actnow reach project, launched in 2007, aims to work with voluntary and community sector organizations to introduce efficiencies with broadband and ICT, further extending the benefits and knowledge into the wider community. The project will also work with strategic partners such as schools and housing associations to develop community computing centres aimed at engaging members of the community with little or no experience of the internet and ICT.

Next generation infrastructure

Keep pace with broadband deployments

The Convergence programme in Cornwall, 2008–2013, aims to build a knowledge economy in a rural area. Actnow have placed the need for next-generation broadband at the core of this proposition, and are actively researching opportunities to ensure that Cornwall is able to keep pace with broadband deployments in progressive economies around Europe and globally. Next-generation broadband is likely to require significant investment in telecommunications networks and the Convergence Operational Programme is proposing a significant investment in this under the "Transformational Infrastructure" axis.

3.2.5 Company case studies from Cornwall

In this section, two Cornish companies are analyzed with respect to the impact broadband has had on their business processes. Although the companies are from the services sector, they vary in their field of activity and the way they make use of broadband.

In Section 2, it was argued that a broadband infrastructure being in place is not sufficient to realize the benefits of broadband. A composite indicator for broadband readiness (the ability and awareness to make use of broadband technologies) and one for use of online services have been developed. The company case studies take account of these composite indicators and show how companies take advantage of online services.

Fire Crest[5]

Fire Crest sells, installs and maintains fire protection equipment, such as fire alarm systems and extinguishers, for professional facilities and property management agencies. Fire Crest serves about 4000 clients, some of which are in charge of up to 60 premises. 80%

[5] This section is based on an interview with Robert Catanzaro, Managing Director and founder of Fire Crest, and Harry Hart, Operations Director, which took place in Hayle, Cornwall on 25 September 2007.

of FireCrest's clients are located in Cornwall; the rest are based in Devon and the Isles of Scilly. The company was founded in 1987. It grew from two employees in 1999 to 13 employees today and acquired a competitor in 2005.

Broadband readiness and awareness. Fire Crest recognized early the importance of broadband and eagerly awaited the possibility to connect. As soon as access was finally available in May 2006, the company successfully implemented several broadband-based technologies. However, its plans to go further are limited by the bandwidth (the nearest telephone exchange is 4 km away). In the beginning, the bandwidth available was only 0.5 Mbit/s (downlink) and 0.1 Mbit/s (uplink). The company now has a 2.5 Mbit/s downlink and 0.5 Mbit/s uplink but emphasizes its need for a high-speed broadband connection.

An early adopter of ICT

The company was well aware of the opportunities broadband could offer. The broadband readiness of the company (IT skills and awareness) can mainly be attributed to the technical background of its founder. The founder of Fire Crest participated in developing a user-friendly customer relationship management (CRM) system in the early 1990s. It was the first Windows database existing for his industry. The system became a commercial success in itself and also meant a great improvement for the company. However, when the IT administrator left the region, he could not maintain and further develop the database from a remote location without broadband. The company had to use a simpler standard product, with high costs for migrating to the new system and a loss of information and functionality.

Voice-over-IP, e-procurement and satellite positioning

Use of online services and its benefits. Thanks to the support of actnow, the company could invest € 3500 into VoIP hardware and use the services of an IP-telephony service provider in Devon. The company reduced its annual telephone bill by 75% (from £1200 to £400). In addition, the telephone line was formerly often busy and only one call at a time could be answered. With VoIP, Fire Crest can use 10 telephone lines with unlimited communication time and has about 20 different telephone numbers at its disposal. This allows Fire Crest to offer better and more personalized services to its clients, e.g., by offering local numbers and by keeping the number of an acquired company.

Fire Crest also makes extensive use of the internet. It searches the internet for about 90% of its supplies. By benchmarking its own prices on the internet, the company ensures that its prices remain competitive. The company also gets better prices from suppliers, who may reduce their prices considerably when confronted with better offers for the same product from the internet. For example, a local supplier of Fire Crest reduced the price of an often needed fire alarm device by 35%. Fire Crest can also find providers who offer better quality or innovative products. Fire Crest is thus able to offer services and equipment that provide more added value and to identify new markets and products through broadband.

To ensure good quality of service for a great number of buildings, Fire Crest has to report to its clients regularly. With broadband, exact and updated information, extracted directly from the company's database, can periodically be sent to the clients by e-mail and fewer physical meetings are required.

The vehicles of the six engineers are equipped with a satellite positioning system. Their position and speed can be displayed in real time on a map on a computer at the company's office, together with information on the client (e.g., his location). The system is a very efficient planning tool as well as an emergency management system; an engineer can be sent to a client' site very quickly.

Through flexible working, the company could expand its area of operation

Moreover, Fire Crest can offer its staff greater flexibility. This is important for efficient allocation of resources, given the size of the company and the large territory it serves. The engineers are provided with a client management list and a work schedule via the network and do not need to come to the office. The IT system of the company is accessible from the employees' homes via a virtual private network (VPN). It has ensured continuation of business in several cases, e.g., when engineers were stuck on the Isles of Scilly for a few days due to bad weather but could work from this remote location as if they were at the office.

Use broadband instead of going to the client's place for trivial maintenance

Future prospects. To one potential client, Fire Crest has suggested installing innovative alarm panels with remote monitoring over the internet. Such a monitoring system would reduce the need for physical intervention with the alarm devices and would enable Fire Crest to expand the territory it serves. Likewise, Fire Crest would like to offer online training videos to its customers. According to Fire Crest, there is currently a market opportunity for providing training for professionals (installation of security device) and individuals (simple use). However, this market can only be captured with a faster internet connection.

Results in brief – Fire Crest (www.extinguisher.com)

E-procurement
- 80–90% of all supplies benchmarked through the internet
- Cost reductions can be 35% per item
- 75% reduction in telephone costs through VoIP

Customer relations
- 10 telephone lines through VoIP instead of three landlines; the number of requests that can be answered has quadrupled
- Better customized services and information
- New markets can be approached, new products can be offered

Other
- Price transparency through the internet maintains competitiveness
- Reduced travel costs
- Flexible working causes less labour slack

netpack[6]

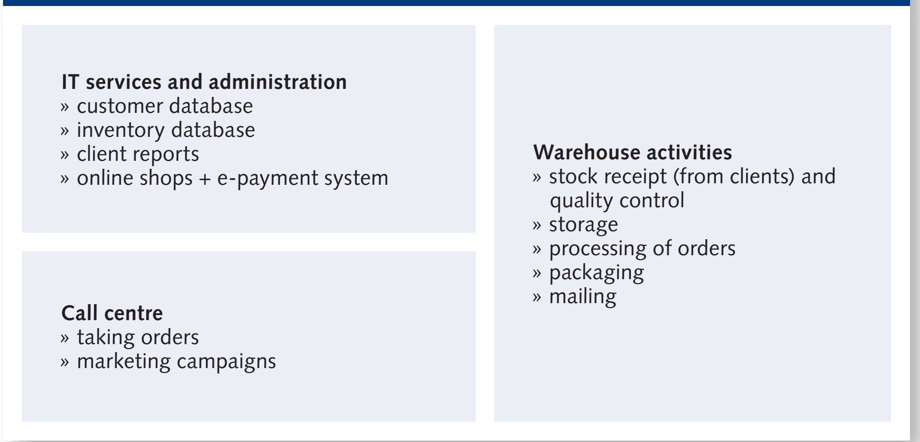
Netpack is a logistics outsourcing company. It has offered a full service for organizations selling goods remotely over 15 years. Its main clients are charities that sell goods such as toys, gifts and Christmas cards to their supporters (customers) via mail order. The customers are mainly from the UK but increasingly call from all over Europe. Netpack does the stock-keeping for its clients, maintains a call centre and online shops to take orders,

6 This part is based on an interview with Tim Brawn, Managing Director at netpack, which took place in Penzance, Cornwall, on 25 September 2007.

and does the packaging and mailing. Netpack has 25 employees and needs to double this number during the pre-Christmas period. On a normal day, netpack deals with around 700 orders. Within one year, the company has doubled the number of orders.

Broadband readiness and awareness. Netpack started as a fulfilment service provider. The customers had to order from a mail-order catalogue. To successfully turn the business into an e-business, two incidents coincided. First, broadband infrastructure was made available to the company in 2006 and netpack got connected immediately. netpack now has the fastest ADSL connection available in Cornwall.

Figure 27 – Business processes and organization of netpack



Second, a specialist in direct marketing took on managerial responsibility. The manager was well aware of the potential of broadband and believed in the market opportunity of online sales. He energetically followed plans to change the company's structure to make it ready for e-business. He developed the IT skills of the company and reengineered key processes to take advantage of new technologies.

Expand the company's range of services

Netpack has not only redesigned its processes in order to offer clients and customers a complete e-commerce solution. In addition, the company has diversified its service portfolio (see Figure 27): it now arranges telemarketing campaigns and designs and operates online shops including online payment systems.

Reduce delivery times from 15 days to 3 days

Use of online services and its benefits. Broadband has been key to the development of new services and process innovations. Netpack receives more and more orders through online shops, though the call centre remains important. The charities that netpack serves have a target of 21 days for delivery. Before broadband was available, netpack delivered within 14 to 15 days. Now, the products are usually mailed the next day or within three days of receipt of order.

Netpack maintains a customer database which is synchronized regularly with its client's database. The database contains information such as the name, address and purchase history of customers.

In addition, netpack regularly updates its clients on sales (e.g., average cost of sales, number of customers), stock levels and supply needs. These daily and weekly reports are directly extracted from the company's database and sent to clients by e-mail. Delivery schedules and listings are transmitted electronically and directly integrated into netpack's database. Without broadband, it could take half a day to send large data files. Offline synchronization (e.g., through a CD sent by post) would have required a lot more time and effort. To avoid losses of critical information, all data is saved as a backup in London and in Holland each night, which would be impossible with a narrow-band connection.

Formerly, all credit card payments received through the call centre were keyed in manually, then semi-automatically extracted from the database and sent to the bank in batches once a day. This process could take between one and four hours. Now, payments from both the online shops and the call centre are processed in real time through a secure e-banking online terminals. This allows the checking of the availability of credit, avoids typing errors and ensures a fully-automated process on the bank's side. Netpack also uses VoIP for telephone conferences and Tim Brawn can work from his home linked through a VPN to the company's IT system.

Twice as much activity with the same personnel

The company's productivity improvements are impressive. Netpack has optimized its internal processes and increased efficiency by 10–15%. Since many tasks have been automated (online banking, reporting), netpack needs fewer administrative personnel. The speed of processing orders has doubled. "We deal with twice as many orders, clients and products as last year, with the same personnel", says Tim Brawn. In contrast, costs for the warehouse and packaging are mostly fixed costs, not much influenced by the innovations made possible by broadband.

Higher bandwidth is required

Future prospects. The company almost doubled its warehouse capacity by the end of 2007 and is likely to double its staff in 2008. Netpack is in contact with several new clients and should pick up business with them soon, as the e-commerce market is still expanding quickly. Netpack also intends to increase flexible working among its staff. Tim Brawn is convinced of the necessity of a higher speed (fibre-optic) broadband connection: "I don't know what we would use it for, but I'm sure we would use it! The infrastructure creates the entrepreneurs."

Results in brief – netpack (www.netpack.co.uk)

E-commerce
- Orders increased by 100%
- Real-time payment service saves time and reduces error rate

Customer relations
- Clients increased by 100%, Reduction in delivery times by around 75%
- Better customized services and information (client reports, payment services)
- New services (online shops, marketing)
- Sending client reports saves several hours each day
- Synchronization of customer database

Supply chain management
- Delivery schedules of supplies are sent electronically and integrated into the company's database
- Speed of processing orders has increased by 100%

Other
- More efficient internal processes (by 10–15%)
- Less administrative personnel
- Secured data (daily backups)

3.2.6 The regional impact of broadband in Cornwall

Broadband has become indispensable

In 2005, actnow conducted a survey on the various impacts of the actnow programme on businesses [76]. Even though the report focuses on the benefits of broadband at a micro-economic level, it gives a good impression of the positive effects of broadband for the region. According to this survey, most of the companies using broadband have experienced lower costs for telephone, mail and printing (over 75% of the responses) and felt that broadband has improved their business performance considerably: of the 700 respondents, 81% declared that broadband is crucial for their activity. Many examples of companies are given which could not have carried out their business (or not as successfully) without the help of broadband.

Actnow has also changed the image of Cornwall, from a rural laggard to a region where it is worth living and working. It became more attractive for investors, for innovative businesses and for young people who are returning to the region. According to actnow, about 4300 broadband-related jobs have been created since 2002 (including through start-ups) and the contribution to the annual GDP of Cornwall has been about € 140 m.

A boost to the regional economy

Without broadband, Cornwall could not have achieved the highest level of start-ups using new technology in the UK. In 2004, 37% of the start-ups in Cornwall used new technologies – it should be noted that the ICT sector only accounts for about 1% of the jobs in Cornwall ([85] p. 19). According to LINC ([85] p. 20), the “investment in broadband technology has been a significant boost to Cornwall and the Isles of Scilly, given its peripheral location”.

Table 5 – Cornish development in comparison
Source: (1) actnow, (2) LINC ([85] p. 19f.), (3) Eurostat.

	Cornwall	South-West	UK	EU25
ADSL coverage (2006, % inhabitants) (2), (3)	99%	--	99%	85%
ADSL penetration (2006, % households) (2), (3)	37.1%	33.1%	30.5%	29.4%
Start-ups using new technology (2004, % companies) (2)	37%	29.9%	--	--
Use of e-commerce among businesses (2006, % companies) (1), (3)	41%	--	--	38%
Number of jobs created (1)	4300	n.a.	n.a.	n.a.

Although Cornwall’s GDP still lags behind that of the UK and the EU, it has improved relative to the EU25 average from 68% (2000) to 76% (2004) [53]. Since 1995, the GVA of Cornwall grew by more than 60%. Only since the start of the Objective One programme in 2000, has the GVA of Cornwall grown at a higher rate than the national economy and the region of which it is part (see Figure 28).

The strongest impact occurred in the business services sector

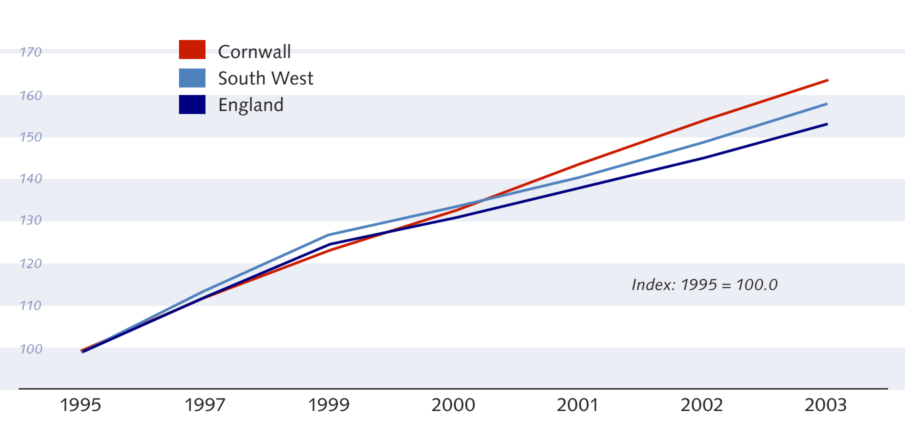
The strongest growth has occurred in “real estate, renting and business activities” (NACE section K) and “retail, wholesale and repair” (NACE section G). It reflects the fact that the service industry in Cornwall is of greater importance than the manufacturing industry.

The analysis makes use of the following sections from the Statistical Classification of Economic Activities in the European Community (NACE Rev. 1, 1996):

Section G: Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods
Section K: Real estate, renting and business activities

Section K is of specific relevance when trying to isolate the impact of broadband on the economy: it includes all "computer and related activities" and thus companies offering business services who are major beneficiaries of broadband usage. Therefore, in the following discussion, the development of section K in Cornwall is described with regard to GVA, productivity and employment.

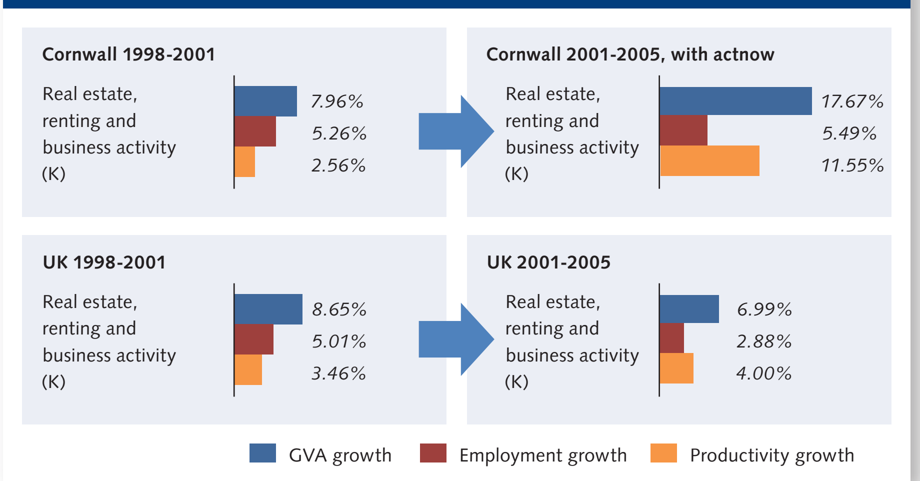
Figure 28 – Gross Value Added, 1995–2003



The GVA of section K in Cornwall (see Figure 29) increased about 8% between 1998 and 2001. The increase was slightly lower than that at the national level. Between 2001 and 2005, however, the situation turned around: whereas at the national level the increase in GVA became smaller, it more than doubled for Cornwall. The GVA in this sector in Cornwall increased by almost 18% between 2001 and 2005 (compared to 7% in the UK).

Source Figure 28: LINC ([85] p. 4)

Figure 29 – Yearly growth in GVA, employment and productivity in Cornwall and the UK



Between 2001 and 2005, Cornwall could maintain and even slightly improve growth of employment in section K, compared to the period 1998 to 2001. In contrast, at the national level, the increase in employment dropped by more than 40% during the same period.

Productivity in Cornwall is low (which is reflected in its lower wage level). This is partly due to the economic structure of Cornwall, with high shares of activity in economic sectors with low productivity ([85] pp. 15, 22 f). In contrast, in the business services sector, productivity rose considerably after broadband became available in Cornwall. Yearly growth in productivity more than

Source Figure 29: figures from ABI/ National Statistics, UK quadrupled and reached 11.5% between 2001 and 2005. During this same time period, productivity only increased by 4% across the UK in the business services sector.

Broadband fosters the development of high-value-added activities and well-paid jobs

However, some problems remain. In order to address the problems of its low wage economy, Cornwall needs to increase the proportion of knowledge- and technology-intensive business sectors. Broadband clearly presents an opportunity for more workforce skills to be spent on innovation, which would foster an economy that is "knowledge and innovation driven" ([85] p. 16). In the light of the great number of low-paid jobs in tourism, agriculture and retail in Cornwall, the support from actnow focusing on jobs in higher-value-added services sectors is even more valuable.

Another challenge is to maintain the early advantage secured by actnow. Cornwall needs to further develop its broadband infrastructure to be able to compete with urban centres. However, 51% of phone lines lie beyond a 2 km radius of an exchange and would thus be excluded from highest speeds, even if exchanges were upgraded. In the longer term, only a significant investment in an optical fibre network will ensure that Cornwall is not left behind again ([85] pp. 19 f).

3.3 Piedmont, Italy: a region at the forefront of Italian industry

3.3.1 Overview

Figure 30 – Location of Piedmont in Italy

The region of Piedmont is located in the north west of Italy (see Figure 30), bordering France and Switzerland. It consists of eight provinces and Turin is the capital of the region. The territory is about seven times the size of Cornwall. Piedmont is characterized by a much greater number of inhabitants and businesses than Cornwall and by a different industrial structure.

Traditionally, Piedmont has had a strong manufacturing and metal-processing industry. Though of decreasing importance, manufacturing still plays an important role in Piedmont and accounted for about 23% of the regional GVA in 2005 (Source: ISTAT). 95% of the companies in Piedmont are micro-companies (see Table 6).

In 2005, Piedmont had a total GVA of € 103,406.6 million (IRES 2007) and a GVA per head of € 24,000. It was higher than the Italian average GVA per head which amounted to € 21,700.[7]

The industrial activities of the region are concentrated in and around Turin. About 20% of the population lives in the capital. Only 30 Municipal Districts (out of 1206) have more than 20,000 inhabitants.

[7] In 2005, Piedmont had 4.3 million inhabitants and the total population of Italy was 59 million.

Surface [1]	25,399 km²
Population (2006) [1]	4,352,828 inhabitants
GDP (2005) [2]	€ 114,993.2 million
Number of businesses (2006) [1]	413,648, of which 95% are micro-companies and 4% are small companies
% in employment who are self-employed (2006) [3], [4]	28% (Italy: 26.4%)
Regional economy [2]	Mechanical and manufacturing sector; retail, transport and tourism sector; real estate
Number of municipalities [3]	1206

Table 6 – Fact sheet of Piedmont, Italy
Source: (1) WI-PIE, (2) IRES (2007), (3) IRES (2006), (4) ISTAT (2006)

The regional economy is very dependent on the mechanical industry

The economy in Piedmont is very dependent on the mechanical industry (NACE sectors DJ+DK), accounting for 54% of the manufacturing sector in Piedmont as compared to 29% on average in Germany, France, Italy, Spain and the UK. Economic development towards other economic sectors in accordance with the Lisbon strategy has been considered a necessity for sustaining high economic activity in Piedmont in case the crisis in the regional mono-industry should continue ([105], [106] and [107]).

In Piedmont, the structural differences between urban centres and rural areas are very strong. In particular, the mountain areas are only sparsely populated and suffer from depopulation and low economic activity. Another problem was the old telephone infrastructure of the region. This situation is reflected in the broadband-related indicators. Despite broadband being available to about 90% of the population, broadband penetration levels among citizens outside urban centres remain very low (below 5%, [114] p. 32). In contrast, almost 26% of the citizens in Piedmont had access to a broadband connection in 2006 ([112] p. 28). This situation characterizes a long-term digital divide in Piedmont, which had to be tackled by adequate broadband development programmes.

Figure 31 – Map of Piedmont (backbone path in red)

This fact was recognized early and was one major driver to launch the WI-PIE programme, at a time when broadband was mainly available in densely populated areas. In 2004, broadband coverage reached more than 80% of the population but only 31% of the municipalities.

3.3.2 The WI-PIE programme[8]

Source Figure 31: Courtesy of WI-PIE/ CSI Piemonte

The regional administration in Piedmont (Regione Piemonte) has long been engaged in the development of the knowledge society and the use of ICT in public services. The creation in 1977 of CSI-Piemonte, a public IT services provider for all public services in the region, permitted the centralization of the technical competencies and IT development strategy

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[8] This section is based on a meeting with Vittorio Vallero as a representative of both the WI-PIE programme and the CSI-Piemonte, which took place in Turin on 28 November 2007, and on materials supplied by WI-PIE.

for public bodies in the region. The portal sistemapiemonte.it for e-government services in Piedmont is one of the noteworthy achievements of this cooperation between the region and the other local public authorities.

In 1998, the regional administration and the CSI-Piemonte launched the RUPAR project, aiming to connect all public bodies in the region to the internet. This development concerned more than 6000 access points in the region, including public libraries and schools, and was necessary to roll out the e-government programme. Most of the connections in rural areas were narrow-band connections over dial-up modems.

Provide all public services with broadband connectivity

The success of the RUPAR project led to the launch in 2005 of the WI-PIE programme by the Piedmont region, the CSI-Piemonte, IRES and the CSP (two publicly funded regional research institutes in economy and ICT). The programme aims to provide all public bodies in the region with broadband internet access and to promote broadband more widely in the region. The budget of the programme amounts to about € 100 million, of which about 64% has been spent on infrastructure. The financial resources were provided by the European Regional Development Fund, different national and regional as well as private funds and organizations (CIPE, TP, ICT Regional Department Funds, etc.)

The objectives of the programme are defined in the following seven "strategic lines" (Linee Strategiche, LS).

Monitoring the economic impact is part of the programme

LS 1: Observatory (ongoing since 2005). Since the beginning of the programme, particular attention has been put on monitoring and evaluation of the WI-PIE programme, and, more generally, the regional ICT development and the impact it has for the region. The Piedmont ICT Observatory (PICTO) was established by the regional government. It is the result of a collaboration between the socio-economic research institute (IRES), CSI-Piemonte, CSP, ISMB (an ICT-focused research centre) and Politecnico di Torino (a public engineering university). The ICT Observatory ensures the systematic evaluation of the programme and its benefits and results. It delivers a regular analysis of the information society in Piedmont, especially of the diffusion, usage and impact of ICT among citizens, enterprises and companies.

LS 2: Backbone implementation (2005–2006). The construction of the WI-PIE backbone is not based on the installation of a specific fibre-optic infrastructure, but rather on bitstream access to the existing infrastructure owned by the telecommunications service providers in the region. The backbone was operational in late 2006, connecting all strategic points (main cities) in Piedmont, and providing bandwidth through the "internet exchange" TOP-IX to public services and private companies. An internet exchange is an innovative infrastructure-sharing model, quickly gaining market share in Europe (www.euro-ix.net). It is targeted at intensive internet users, such as large IT services companies, utilities or online content providers, willing to connect to the internet infrastructure directly, without using the service of an internet service provider. About two-thirds of TOP-IX members belong to the telecommunications sector, the rest are mainly local governments, research institutions, broadcasters and manufacturers.

LS 3: Facilitating access (2005–2007). This strategic line focused on the development of the optical fibre network between the backbone and the main distribution frames (telephone exchanges) of the telecommunications infrastructure. With a budget of € 32 million, it has been the most expensive of all strategic lines. Public intervention should enable the private market to sustain itself. The approach chosen was to develop a broadband infrastructure and make it available to market operators under competitive conditions (technological neutrality and open access). Internet service providers have access to the "dark fibre", but no telecommunications service is directly provided by WI-PIE to end users.

LS 4: Wireless territory (2005–2008). The fourth strategic line aimed to provide satellite broadband and WiMAX connections to areas that are too remote to be connected over wired broadband to the internet. Its focus is especially on the mountain communities in Piedmont (96% of the mountain communities are Objective Two territories). A two-way satellite umbrella coverage was to be connected to the backbone and wireless technology was to be used to spread the satellite signals to such municipalities. LS 4 is also a tourism project which allows visitors to have an internet communication in a mountain hut and, for example, to book the next hut. About 200 hosts have been installed above 2000 m (about half of them are public).

LS 5: Internationalization and integration into the national system (2005–2008). The objective of LS 5 is to stay well connected globally and to ensure connections with other Italian and European networks, once a competitive, functioning network has been created in the region. LS 5 prevents WI-PIE from becoming an isolated regional network.

LS 6: Research, the academic world and schools (2005–2008). Through LS 6, the programme is connected to the academic world and explores ways to benefit educational institutions. Some pilot projects have been launched with mountain communities, one project promotes co-operation between schools and universities, and another has developed content for schools, in particular to promote e-learning.

Promote the use of online service

LS 7: Developing broadband services (2005–2008). With broadband becoming widely available, new business models and services need to be created. LS 7 was set up to elaborate innovative means of communication, for example, between public administration and enterprises. However, LS 7 is still in a relatively early stage. In 2007, a Memorandum of Understanding was signed between Piedmont Region and Telecom Italia to aggregate and stimulate demand and investment in innovative services.

In view of low adoption rates, especially in rural areas, there is still a great need to reduce the digital divide. Therefore, WI-PIE has also been trying to get people to participate and providing them with valuable content, once a basic infrastructure has been installed. For example, in order to increase penetration levels, meetings with local community members and mayors have been organized. However, broadband adoption in remote areas remains problematic.

3.3.3 The project RIAP in Piedmont

Use broadband in industrial districts

In addition to WI-PIE, there is a number of organizations and initiatives linked to ICT development in Piedmont. Among others, a regional project called "From Industrial

Districts to Digital Districts" (RIAP) was launched in 2004 with the help of the Community "Innovative Actions" programme.[9] The project had a total budget of € 7.75 million and ended in 2006.

The general objective of this project was to support the structural transformation of areas with a strong tradition of industrial production. The project aimed to provide assistance for building up an industry for innovative services in three areas: Alba, Biella, and Borgomanero–Oleggio. This is in line with the regional strategy which supports the diversification of the economy and its movement towards the knowledge economy. The project was managed by local organizations so that it could be well adapted to local needs and local social cohesion was strengthened.

Foster the development of the knowledge society

The areas were characterized by low urbanization and many small residential centres. They were not serviced by main national roads or railroads. Each of these areas had a tradition as an industrial district, though with different industrial specializations.

The main goals of RIAP were to carry out trials in making broadband available, in developing new high-added-value digital services and in promoting the use of ICT among SMEs, public bodies and individuals.

For example, the project made an e-procurement platform available for SMEs, designed to support B2B. Another service offered was related to the financial and administrative management of a company.

Three sub-projects within RIAP referred to the development of internet services to be used by citizens and tourists, offering access to a digital databank or a geographic information system through an easy-to-use interface. Moreover, new online public services were developed for citizens, and training programmes and e-learning were offered as a trial in order to improve ICT literacy.

The project involved more than 180 companies, around 70 public bodies and 15 schools. More than 1500 users participated in the training programmes and in e-learning. More than 250 broadband connections were achieved. In addition, every area was provided with a public Wi-fi hotspot.

Innovative services have been permanently adopted after the end of the project

Even though the project finished in 2006, the online services for companies are still available. They became part of a web portal which has been created since the end of the project. As a privileged entry-point, the portal provides information about the district and promotes ICT opportunities for local companies.

Follow-up action includes the further improvement of broadband connectivity in one of the three areas, the set up of new services for tourists (based on those developed in the project) and a wider diffusion of e-learning as training tool.

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9 http://ec.europa.eu/regional_policy/innovation/index_en.htm

3.3.4 Measuring the impact of broadband on Piedmont

Broadband penetration in Piedmont

Not enough data is available at the regional level in Piedmont to construct the composite indicators defined in Section 2.1 of this study. Still, the impact of the WI-PIE project can be measured using the usual indicators of broadband penetration and the use of online services in Piedmont, as compared to Italy and the EU.

Broadband penetration among households in Piedmont is still lower than the European average, though it is higher than the Italian average. Broadband penetration among companies, however, is higher in Piedmont (85%) than in the rest of Europe (80%). Between 10% and 15% of companies with more than 10 employees in Piedmont have access to a connection of more than 10 Mbit/s and 36% of the companies are interested in such a connection or higher bandwidth (Source: PICTO, 2007 [116]).

Broadband penetration among companies is higher in Piedmont than in the rest of Europe

	2005				2006				2007			
	EU25	EU15	Italy	**Piedmont**	EU25	EU15	Italy	**Piedmont**	EU25	EU15	Italy	**Piedmont**
Internet penetration in households (%)	48%	53%	39%	**47%**	51%	54%	40%	**47%**	56%	59%	43%	**50%**
Broadband penetration in households (%)	23%	25%	13%	**21%**	32%	34%	16%	**25%**	43%	46%	26%	**37%**
Broadband penetration in enterprises (%)	63%	65%	57%	**73%**	75%	78%	70%	**80%**	80%	82%	77%	**85%**

Table 7 – Comparison of broadband development in Europe, Italy and Piedmont Sources: Eurostat for EU25, EU15 and Italy, PICTO for Piedmont ([115] and [116])

Broadband coverage in Piedmont increased between 2004 and 2007 from 80% to 90.2% of the population and 31% to 63.3% of the municipalities. In March 2008, the DSL infrastructure covered 77% of the municipalities in Piedmont [116].

A comprehensive measurement framework: definition of a set of socio-economic indicators

The Piedmont ICT Observatory (PICTO) has defined eight potential benefits of the WI-PIE programme [114]. To evaluate each benefit for the region, PICTO has developed various indicators (see Table 8). Most of them are composite indicators; only B7 is measured by a single indicator which does not consist of other indicators.

	Benefits of WI-PIE	**PICTO (composite) indicators**
B1	Development of innovative applications	Regional innovative potential
B2	Strengthening of Piedmont's international ICT position	Internationalization of the territory
B3	Increase in competitiveness of the manufacturing system	Entrepreneurial dynamism in the local area ICT adoption by enterprises, ICT awareness in enterprises
B4	Improvement of public services	Online services offered by local and central government Use of online services by citizens and enterprises
B5	Reduction of digital divide	Broadband infrastructure, Broadband adoption ICT usage, Initiatives to improve ICT usage in everyday life

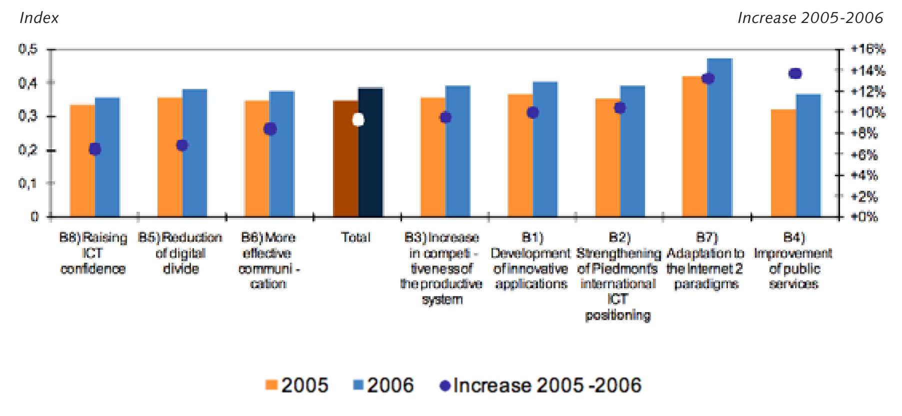
	Benefits of WI-PIE	PICTO (composite) indicators
B6	More effective communication between public administration, companies and research institutions	Experiences with advanced, ICT-supported services
B7	Adaptation to the internet 2 paradigms	Traffic generated by TOP-IX
B8	Raising ICT confidence	Educating people to become players in the information society Take up of ICT usage in everyday life

Table 8 – Assessment of the benefits of WI-PIE (Source: Sistemapiemonte (2007c)/PICTO)

Meanwhile, PICTO has emphasized the difficulty of identifying the right indicators to measure the expected benefits of WI-PIE or, more generally, of a broadband infrastructure. Until now, there have been no standardized indicators that could be taken to measure and compare such benefits on a regional, national and international level.

According to these indicators, the regional economic characteristics related to the WI-PIE programme were improved by 6% to 13% between 2005 and 2006 (see Figure 32).

Figure 32 – The benefits of WI-PIE, 2005 and 2006



Source Figure 32: Adapted from Sistemapiemonte [114] and PICTO

Detail about the composite indicators B1, B2, B3 and B5

Four indicators are of particular interest here because they focus on the economic impact of broadband and the development of online service. These are: the development of innovative applications (benefit B1), the international positioning of Piedmont (benefit B2), the competitiveness of the local industry (benefit B3) and a group of indicators that attempt to assess the reduction in the digital divide (benefit B5).

For these four benefits, the following table lists the indicators used and the weights attributed to them. The indicators relate to regional economic and social impacts of ICT. The monitoring is constantly reviewed by PICTO: the measurement of the benefits is further developed with new indicators being added (see indicators highlighted in red below).

B1. The impact on the innovative potential of the region is mainly assessed by the activities of TOP-IX and by infrastructure-oriented indicators (the number of hotspots and the number of organizations with connections faster than 2 Mbit/s). The important aspect of business process innovation has not yet been included. From 2005 to 2006, this indicator has improved by 10.0% ([114] and PICTO).

B2. In order to assess Piedmont's international ICT position, ICT-related exports have been taken into account. In 2006, the export volume amounted to € 2.14 million (as

Benefit	Composite indicators	No.	Indicators	Weight
B1 Development of innovative applications	Regional innovative potential	1	Number of companies and institutions (schools and public administration) with a connection of >2 Mbit/s (minimum guaranteed speed)	0.7
		2	Number of partners of TOP-IX	0.2
		3	Number of hotspots with broadband coverage	0.1
		6	Number of ICT companies in Piedmont offering innovative services (VoIP, videoconferencing, etc.)	0.0*
B2 Strengthening of Piedmont's international ICT positioning	Internationalization of the territory	4	Exports by ICT companies	0.6
		5	Number of foreign ICT companies newly set up in Piedmont	0.0*
		7	Participation of Piedmont in international ICT-related networks	0.4
B3 Increase in competitiveness of the productive system	Entrepreneurial dynamism in the local area	8	Number of new (ICT and non-ICT) companies in Piedmont	0.5
		9	Number of new (ICT and non-ICT) companies in Piedmont in Objective 2 zone	0.0
		14	% of companies having "external" relations (e.g., collaboration with universities and research centres, involvement in local development projects)	0.5
	ICT adoption by enterprises	12	% of companies using ERP and related systems (for significant production chains)	0.5
		13	% of companies having a website	0.5
	ICT awareness in enterprises	11	% of companies using online public services to interact with government	0.4
		15	% of companies using the internet to develop new products jointly with their partners	0.4
		16	Perceptions of companies about the effects of ICT investments	0.2
B5 Reduction of digital divide	Broadband infrastructure	22	Broadband coverage (by technology)	0.8
		23	Number of telecommunications operators	0.2
		24	Average cost of broadband access (by type of connection)	0.0*
		27	% of buildings with broadband connection	0.0*
		28	% of public buildings (e.g., schools, libraries, hospitals) with broadband connection	0.0*
		29	% of tourist facilities with broadband connection	0.0*
	Broadband adoption	26	% of companies by economic sector with broadband connection	0.5
		26a	Citizens with broadband connection at home	0.5
	ICT usage	31	% of internet users, by type of service and population group	0.2
		32	% of population who can work away from the company's regular site due to ICT or a broadband connection	0.2
		33	% of companies with employees working away from the company's regular work site due to ICT or a broadband connection	0.4
		34	Places or sites equipped with ICT and broadband, which can be used as work sites	0.2
	Initiatives to improve ICT usage in everyday life	25	Automated bank counters with advanced functions	0.1
		30	% of population living in municipalities where public services are available online (per type of service)	0.9

**Indicators marked red are planned for realization in the future.*

Table 9 – Examples of indicators used to measure the benefits of WI-PIE (Source: [114] and PICTO)

compared to € 1.88 million in 2005). About 70% of ICT exports are from the province of Turin. The export volume was highest for radio–television devices and communication equipment. Moreover, Piedmont has participated in various international ICT projects and is a member of a number of European networks. The international positioning of Piedmont as measured by this composite indicator has improved by 10.4% ([114] and PICTO).

B3. PICTO has selected seven (formerly eight)[10] indicators to measure the competitiveness of the local industry (only B5 consists of more indicators). Overall, an increase in competitiveness by 9.6% could be observed from 2005 to 2006 ([114] and PICTO). The number of companies set up in Piedmont increased slightly, by 1.8%, from 2005 to 2006. 51.7% of the companies were set up in the region of Turin (in 2005, 53.7% were set up in Turin). Two-thirds of ICT companies are started in the region of Turin. The competitiveness of Piedmont is therefore strongly dependent on the situation in Turin.

More than half of the companies have perceived cost reductions and efficiency increases to be the main benefits of the use of ICT ([114] p26). In 2006, 81.6% of the companies had a website. For comparison, in 2002, this number was only 69.5%. However, in 2006, 79.4% of these websites did not offer any interactive services. This can partly be explained by the size of the companies in Piedmont: 95% are micro-companies, with fewer than 10 employees.

The digital divide has been reduced

B5. The digital divide has also been reduced through WI-PIE. Between 2005 and 2006, the composite indicator improved by 6.8%. Indicators monitored in this context are broadband coverage and penetration as well as use of online services and teleworking. Broadband coverage was successfully brought to remote areas in order to reduce the digital divide. Despite high coverage, broadband adoption rates are still low in Piedmont. In 2006, the adoption rate among citizens was only 26% (in 2005: 21%). "In the end, it is necessary to intervene in order to stimulate demand" ([114] p. 34).

Impact on the economy: business services and the mechanical industry

Tele-working can reduce the depopulation of remote areas. Yet teleworking is still not widely accepted in Piedmont: in 2006, only 5% of the working population made use of the internet when working away from the company's regular work site. The overall number of employees teleworking in Piedmont was 13.6% in 2006 and has remained stable (2005: 13.5%). This value is much higher than at the national level where it was less than 4% in 2005 ([114] p38).

The analysis makes use of the following sections and subsections from the Statistical Classification of Economic Activities in the European Community (NACE Rev. 1, 1996):

Section D: Manufacturing
- DJ Manufacture of basic metals and fabricated metal products
- DK Manufacture of machinery and equipment n.e.c.

As was done for Cornwall, a sector analysis has also been made for Piedmont. Again, sector K has been chosen because of its broadband dependence (it includes "computer and related activities" and business services). Growth in GVA, in employment and in productivity are again the indicators chosen to describe the economic development of the region.

[10] Indicator 9 has been eliminated and has not been taken into account since 2006.

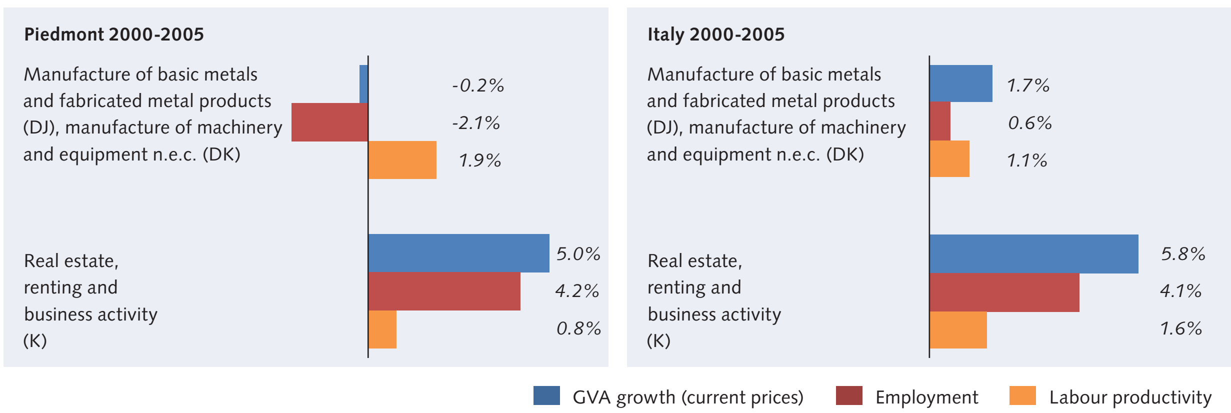
Since the automotive industry is particularly important for Piedmont, two subsections of sector D are also taken into account. They refer to the manufacture of basic metals and fabricated metal products (DJ) and the manufacture of machinery and equipment not elsewhere considered (DK). Companies in both subsections are strongly dependent on automotive manufacturing. Subsections DJ and DK taken together accounted for 51.6% (54%) of total manufacturing (sector D) in 2000 (2005). It well illustrates the strong specialization of the regional economy and the mono-industry on which it depends.

Although Piedmont is one of the biggest industrial areas in Italy, growth in the manufacturing sector has been disappointing between 2000 and 2005 (see Figure 33) and even lower than at the national level. In contrast, sector K grew by 5% during the same time period; however, this was still not as much as the national average (5.8%). It indicates that the market for services included in sector K is not yet saturated and that there is still potential for growth.

Only productivity growth in subsections DJ and DK in Piedmont is significantly higher than at the national level: in these subsections, productivity increased by 1.9% in Piedmont, whereas it only increased by 1.1% at the national level.

However, an increase in productivity at the same (or even decreasing) output yields a reduction in employment. Employment in subsections DJ and DK decreased by 2% in Piedmont, whereas at the national level it remained stable. In sector K, growth in employment at the regional level was similar to the national level between 2000 and 2005.

Figure 33 – Yearly growth in GVA, employment and productivity in Piedmont and Italy, 2000–2005



Source Figure 33: Based on figures from IRES (2007)

Between 2000 and 2005, the manufacturing sector in Piedmont seemed to be in a state of re-structuring. As mentioned, the difficult situation prompted the Regional Government to adopt policies that aimed at strengthening the tertiary sector and the knowledge economy.

In view of stagnating growth, an increase in productivity in the manufacturing sector could mainly be achieved by process innovation. Yet productivity improvements due to the re-engineering of business processes yield positive results only after a time lag.

Without broadband, such process innovations could not have been implemented. In 2006, broadband penetration among companies was 80% [113]. 15% of the companies surveyed by the ICT Observatory have VDSL connections. This is an unusually high number: it shows the need for companies in the region to innovate and optimize their business processes in order to remain competitive.

3.3.5 Analysis of the success of the WI-PIE programme and prospects for the future

The WI-PIE programme has mainly been successful because of its integrated, strategic approach and its organizational effectiveness.

Piedmont Region has tackled the problem of broadband connectivity as one element of a comprehensive strategy which involves a great number of players from the public and private sector. The high-level support created awareness of the important role broadband could play for the region. A broadband community has been set up to promote the benefits of broadband and develop concerted action.

The WI-PIE programme is embedded in this wider strategy of increasing ICT adoption in the region. The Regional Government has supported the WI-PIE programme, and local governments and other local players (public and private bodies) have been involved in its implementation. Funds have been received from a range of different sources. In the meantime, the technical and administrative co-ordination has clearly been attributed to CSI-Piemonte which could aggregate the demand of the public sector efficiently.

In addition, the parallel controlling and assessment of the programme by PICTO has been of focal importance and allowed to adjust the measures taken, if necessary. The Observatory does not only evaluate regional ICT initiatives and document the progress of ICT usage, it also triggers discussion and raises awareness of the issue by making the information accessible to the public. Moreover, it seeks to lay open the close relationship between innovation and regional development.

Tackle both supply and demand insufficiency

The programme has not only concentrated on influencing supply but has also made efforts to strengthen demand. When compared to the actnow project, the WI-PIE programme has put a greater emphasis on building up a broadband infrastructure. This can be attributed to the fact that because of the difficult topography in Piedmont, greater efforts were required to make broadband available throughout the region. Another reason is the early start point of the programme which dates back to 1998. At that time, the development of an infrastructure was more in the foreground than the development of related services.

In the future, greater attention will be paid to the 7th strategic line: developing broadband services. However, LS 7 mainly focuses on innovative communication tools such as videoconferencing. This focus will need to be extended to include business services so that the use of online services will be strengthened. RIAP has shown what such support could look like, even though the projects were carried out on a trial basis.

When adequate services are offered, ICT adoption will be improved. WI-PIE aims at fostering network utilization through the development of broadband applications. In particular, local public services have been developed successfully, as high usage rates for e-government demonstrate.

A remaining problem is the lack of broadband awareness among companies

According to WI-PIE, a remaining problem is the lack of awareness among companies which do not understand broadband as a business opportunity. In order to fully take advantage of broadband, the re-organization of business processes is required; until now, that has been neglected by many companies. TOP-IX encourages the spread of new business models; however, about 80% of the companies they support belong to the entertainment industry (B2C) rather than initiating broadband-based modernization of the business processes in industrial and B2B sectors. The broadband readiness factor clearly needs to be built up.

3.4 Conclusions on the case studies

The case studies have shown two different approaches to using broadband as a tool for regional development. They have also illustrated the usefulness and importance of the three composite indicators identified in Section 2.1: actnow placed emphasis on broadband readiness and the use of online services; the WI-PIE project focused on infrastructure development.

actnow focussed on demand stimulation

Even though actnow also rolled out an infrastructure, they put much more effort into strengthening broadband readiness in Cornwall and promoting the use of online services. On a very local level, they advised micro-companies regarding business models and enabled them to make use of and benefit from broadband. Thus, actnow was a very successful project with a focus on demand stimulation. In so doing, the project has made a considerable contribution to growth and employment in the region.

In Piedmont, the development of a broadband infrastructure was a prerequisite

In Piedmont, the development of a broadband infrastructure was a prerequisite for the region to benefit from new technologies. The plan to extend broadband coverage widely was first focused on the infrastructure and then aimed at the development of new services based on online technologies. The programme started much later than in Cornwall (2005 as compared to 2002 for Cornwall) and its impact on the regional economy cannot easily be measured yet.

Both projects paid much attention to developing an evaluation framework

Both projects paid much attention to developing an evaluation framework for their action. Similarly, the composite indicators for infrastructure, broadband readiness and use of online services as developed in Section 2.1 provides a systematic evaluation of the economic and social impact of broadband which can be compared on a regional and international level.

Broadband has a positive impact on productivity and growth

The regional economic statistics in both cases clearly demonstrated that broadband development does have a positive impact on productivity and growth:

- In the case of Cornwall, a strategy aimed at increasing the use of broadband services in small and medium companies achieved amazing results in a very short time. The interviews in the companies left no doubt about the impact of broadband on innovation, competitiveness and growth in companies of all sizes and in any business sector. The impact of actnow on growth and productivity in the business services sector is visible in the regional macro-economic statistics.

- The WI-PIE programme in Piedmont started three years later than actnow. It is still early for an evaluation of its impact on the regional economy. Anyhow, the regional economic characteristics monitored by the ICT Observatory in Piedmont were improved on average by 9% between 2005 and 2006.

The two following parts of this report present a framework for an evaluation of the impact of broadband on productivity (Section 4) and growth (Section 5) at the macro-economic level. The comparison of the two case studies above with the theoretical framework provides an enlightening perspective on the impact of broadband on the economy.

4 The impact of broadband on productivity

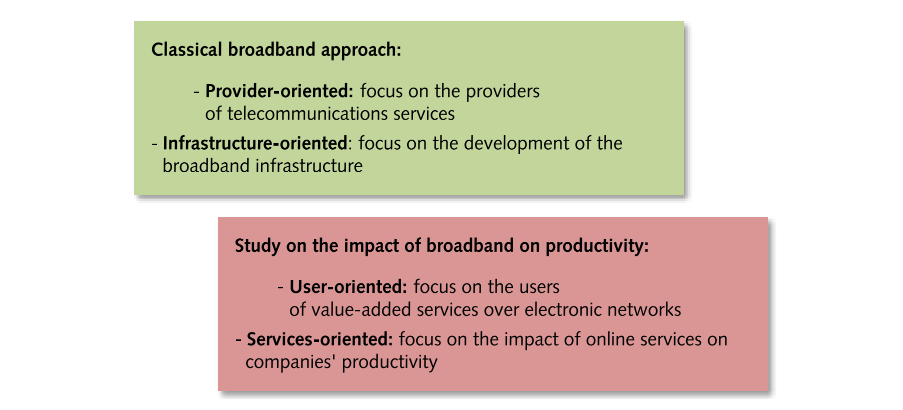
4.1 Overview of the methodological approach

Most analysis of broadband development so far focus on the provision of telecommunications services. This approach is based on market volumes in the broadband telecommunications sector, the development of the broadband infrastructure and the increase in broadband penetration in households and companies, at the connectivity level.

Value-added services are crucial to the economic impact of broadband

Telecommunications services are a way to provide a wide range of value-added services over electronic networks. These services ease communication between individuals, public services and companies. The most important economic impacts of broadband are related to these value-added services.

Figure 34 – Differences between most approaches to broadband so far and the approach used in this study



In order to assess this economic impact, the focus of the analysis needs to be shifted from the telecommunications market to the use of online services by individuals, companies and public services (see Figure 34).

For a complete analysis of the use of online services, different kinds of users are considered: individuals, public services and businesses. These three kinds of user contribute to the economic impact of broadband. In particular, an efficient use of online services by individuals and public services improves broadband adoption in companies. In order to assess the impact of broadband on labour productivity, this study focuses on the analysis of the use of online services in businesses.

The study focuses on the analysis of the use of online services in businesses

Improving the broadband infrastructure is a prerequisite for a broadband-related economic impact. However, broadband-related productivity improvement also requires the integration of online technologies into companies' processes and workflows.

The analysis of the impact of broadband on productivity is basically composed of two steps:

- Step 1: the impact of broadband on productivity is analyzed at the company level on the basis of experiences such as the case studies in Section 3 and previous analyses of statistical datasets in the USA, the UK and Europe.
- Step 2: the macro-economic impact of broadband on productivity is evaluated by multiplying the figure obtained at the company level in the general case with the indicator on the adoption of online services among European companies (see Section 2).

What is productivity?

The general definition of productivity is unequivocal:

productivity = outputs/inputs

When trying to define productivity more concretely, serious questions arise: inputs and outputs cannot always be easily defined and quantified [94].

- Output: the only universal measure of the value of goods and services produced is their price. However, in innovative sectors of the economy, prices tend to drop while the quality of the product rises. In this case, prices are inadequate measures of the real production. For a monitoring of the evolution of productivity over time, it is necessary to introduce a corrective factor to take into account price evolutions. In the case of goods, such factor can be indexed as comparison with other goods. Services are, by their nature, more difficult to compare with each other: the construction of such indices is hardly possible. This raises considerable problems in the calculation of productivity in the services sector (see Wolfl, OECD [132]).
- Input: inputs are usually considered in two categories: labour and capital. In practice, the two can be substituted to a certain extent. For example, a company can invest more in machinery and reduce employment for a constant level of production. Even though this substitution is possible, a quantitative equivalence between labour and capital is very difficult to set. These factors cannot easily be summed into a "total input" calculation. The US Bureau of Census has developed a way of calculating a "multi-factor productivity", using statistical calculations of an equivalence between labour and capital (see the BLS Handbook of Methods) [11].

The productivity analysis made in this study is expected to yield conclusions on employment levels and GDP. Therefore, the simplest definition of productivity is used:

productivity = wealth produced by a worker

Statistically, this ratio corresponds to the following quotient:
productivity = (gross) value added / employment.

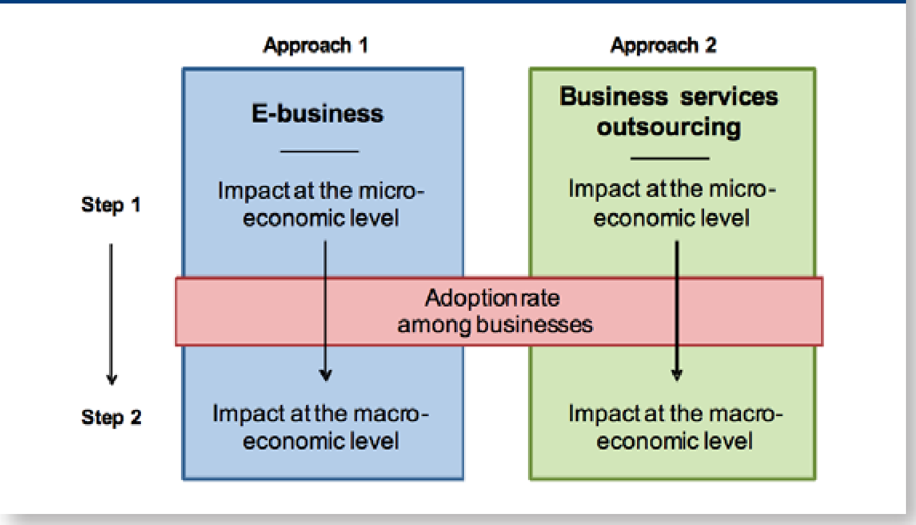
This two-step methodology is used for two kinds of broadband-related productivity improvements. A first approach considers the integration of e-business technologies such as e-government or EDI within a company's processes. For an adequate analysis of the impact of e-business on the companies' productivity, a distinction is made between

Broadband allows better communication with public services and business partners economic sectors (for example, manufacturing and services). This approach establishes the impact of broadband on productivity in a company considered as an isolated entity.

Broadband changes the distribution of tasks within business environments

Broadband also increases the productivity and competitiveness of groups of companies, by allowing each of the companies to specialize in the production of particular goods or services. In particular in the business services sector, this specialization is directly related to the development of broadband, as it allows cheaper and more efficient exchange of information between companies along the value chain.

Figure 35 – Methodological framework: the impact of broadband on companies' productivity



In order to assess this impact of broadband, the productivity improvement related to business services outsourcing is first analyzed at the micro-economic level and then at the macro-economic level (see the two-step methodology above and Figure 35).

The results of these two approaches are used to assess the impact of broadband on growth (see Section 5).

4.2 Use of online services by individuals

Individuals using the internet for personal purposes are also able to understand the importance of using broadband to do a job faster and share information with their environment. In a company, they promote the use of broadband technologies to provide improved or innovative services. The use of the internet by individuals improves broadband readiness in a society.

4.2.1 Entertainment

Growth of the entertainment market

The market for entertainment content is growing very quickly

When speaking about innovation on the internet and the impact of internet on the economy, much emphasis has been put on the growth of the market for online entertainment: music, video, gaming, online magazines, blogs, etc. The market for entertainment content is expected to increase from € 1.8 bn/year in 2005 to 8.3 bn/year in 2010, which is 55% exponential growth per year over five years [111]! This very quickly growing market is directly related to the past and future development of the broadband infrastructure.

The effect of broadband on content and entertainment consumption habits has been tackled in several surveys (including by PEW in the USA [69] and Nanyang Technological University in Singapore [84]):

- There is a displacement between the time spent on TV and on the internet.
- There are no qualitative differences between narrow-band users and broadband users for news, online gaming, listening to web radio, or participating in user-generated-content sites. There are, however, quantitative differences. According to the PEW survey, broadband subscribers do the same things on the internet as narrow-band users, but they use it twice as much: 33% of broadband users go online for fun or just to pass time on the average day, while 19% of dial-up users do so [69].

Since the popularization of broadband internet, a large part of the entertainment consumed over the internet has raised copyright concerns. Digital content consumption is such an important driver for broadband penetration in households that fair business models involving partnerships between entertainment providers and internet providers is a crucial issue for further development of the "next-generation" internet infrastructure.

Broadband allows essential improvements in delivering entertainment services to the user

Broadband internet allows essential innovations in delivering entertainment services to the user. Compared to traditional entertainment services, the offering on the internet represents for the user a qualitative and quantitative improvement: there is a much larger choice and more flexibility in the consumption of entertainment content. For the user, the benefit of broadband for online entertainment lies not only in the higher available bandwidth, but also in the flat-rate pricing model (always on), while narrow-band subscriptions use pay-per-time pricing models.

The online entertainment market is mainly a displacement market

The online entertainment market is mainly a displacement market from other entertainment and content offerings such as traditional music and video support, cinemas, newspapers, books, etc. For music and films, the growth of the online content market does not compensate for the decline of the traditional entertainment markets (see "Interactive content and convergence", 2006, on behalf of the European Commission [111], sections 2.1.1.1, 2.2.1.1 and market estimations given for 2005 and 2010).

The strategic importance of online entertainment

Households represent about 85% of the broadband market

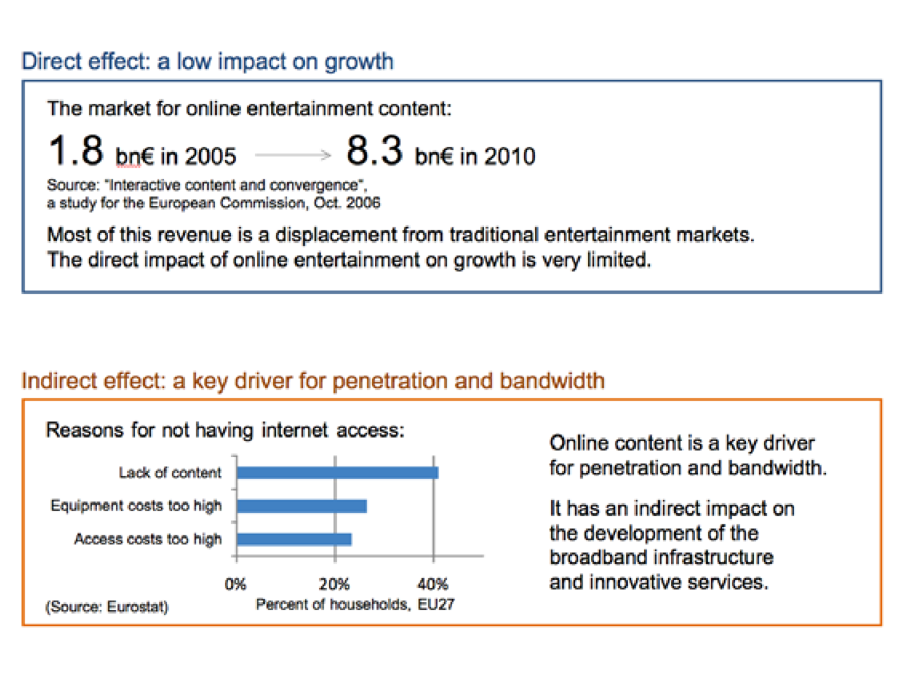
Households represent about 85% of the broadband market, while companies represent only the remaining 15%. Understandably, broadband infrastructure providers pay much more attention to broadband penetration among individuals than the use of broadband by companies. The success of broadband among households is crucial to the development of the broadband infrastructure.

Online content and entertainment is the main driver for internet penetration in households

According to the "Community survey on ICT use by individuals", the lack of online content is the main reason why individuals do not connect to the internet (41%, see Figure 36), even before the price issue (23% and 26% respectively for access costs and equipment costs). The use of the internet by individuals for entertainment has an important impact on the development of the broadband infrastructure, and indirectly, on the telecommunications services available to companies.

Small and medium companies in areas which are not covered by the broadband infrastructure require access to broadband internet in order to modernize their processes and develop new services.

Figure 36 – Online entertainment: a driver for broadband penetration and bandwidth rather than a new market



However, companies have little influence on the internet providers' strategy concerning the development of the broadband infrastructure. To solve this problem, some companies in remote areas have created and financed local associations to foster internet use by individuals. This development model, aimed at stimulating people in the use of broadband internet technologies, has received hardly any political attention so far. Such associations of companies, libraries and users could be a successful way to promote broadband readiness in a territory.

4.2.2 E-learning and research communities

The provision of online courses: a priority?

The internet is an efficient way to spread knowledge

Since the development of broadband internet, the diversification of contents, multimedia possibilities and interactivity has further extended the potential of the internet for education purposes or "e-learning".

Public and private education providers are continuously developing their offering of courses over the internet. According to the study "Megaproviders of e-learning in Europe" [87], there are 26 major e-learning institutions in Europe, each of them providing online courses to more than 5000 students each year.

A motivating learning environment, mentoring and live interaction between students are very important in the learning process, and cannot be as efficiently reproduced in virtual chat rooms as in a classroom. For this reason, the most advanced e-learning providers develop "blended learning", which is the combination of online learning at home for the acquisition of knowledge and collective classroom sessions for practices, exercises and team projects. E-learning courses are considered 50% less expensive than traditional face-to-face courses. Blended learning is only 20% less expensive than equivalent face-to-face seminars, but is more efficient than e-learning [87].

Most benefits of e-learning occur in vocational training and lifelong learning

The evolution of e-learning worldwide shows that the first benefit of e-learning is the reduction of costs in vocational training and lifelong learning. Most of the e-learning offered in Europe is provided by universities to students in their initial education cycle. The demand for online vocational training is under-developed in Europe, in particular in small and medium companies.

The use of the internet for learning purposes: acquiring autonomy in the knowledge society

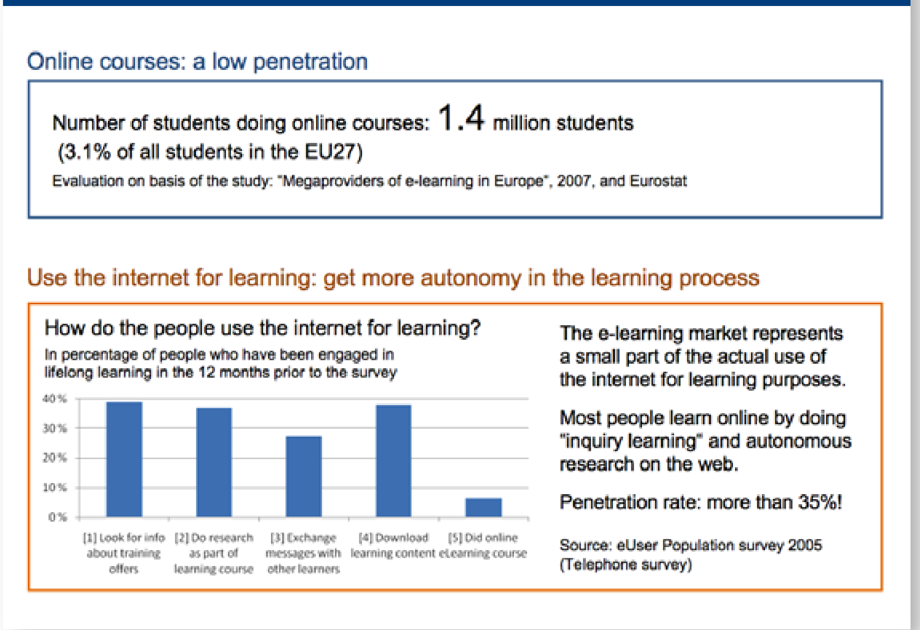
Online courses only concern a small share of the European students

Most approaches to the use of the internet for learning purposes so far focus on online courses. On the basis of data from "Megaproviders of e-learning in Europe" [87], only about 3.1% of European students receive such courses. According to these figures, e-learning seems not to be as successful as expected in promoting the acquisition of knowledge by European citizens. This is contrary to the everyday experience of broadband internet users, for which the internet is a primary source of knowledge in many sectors.

Internet is largely used in autonomous learning processes

A survey made in 2005 for the eUser evidence base among people engaged in lifelong learning [54] shows a very different reality (see Figure 37): more than 35% of the people doing vocational training use the internet for learning purposes, in particular to download learning content, do research and exchange messages with other learners. Less than 10% of them do online courses. The survey was based on telephone interviews: it included people who use the internet and those who do not.

Figure 37 – Use of the internet for learning



These results are much more in line with everyday experience of using the internet for learning purposes. Students do not use the internet to receive knowledge or information provided "ready to learn" by a professor, as they do in the lecture hall. Internet users follow an active learning process: they search the internet for the answer to a question or the solution of a problem. The amount of information available on the internet is so huge that, on the one hand, it stimulates curiosity and, on the other hand, the user has to search for the required information. The lack of control of the information available on the internet also encourages the learner to have a critical attitude towards information.

The internet has made large quantities of information available and searchable

Until now, searching through information bases was limited to dictionaries and encyclopaedias, where the information is classified in a way that makes it easy to search. Large information bases, such as libraries, did not provide a way to search through all the books for the solution of a problem. The internet has not only made the information available to everyone, but has also made it searchable. This kind of learning process has been described in educational theory as "inquiry learning" [120]. It is particularly important in a flexible professional environment, where a worker continuously has to solve new problems and find new solutions instead of simply re-using the knowledge he owns.

Research and professional communities play an important role in the diffusion and creation of knowledge over the internet. In the medical sector, for example, specialists and general practitioners exchange their experience and develop a knowledge base about particular diseases, the detection and treatment of which are not trivial. In the community learning model, once again, the internet encourages learners to play an active part in the construction of knowledge.

The contribution of the internet to research activity in general has an impact in the future and cannot be measured in terms of productivity improvement in today's economy. It is likely that the most active communities today are the precursors of efficient organization structures and responsibility-sharing models which will have an impact on the economy in the future, in particular on small and medium businesses. However, it is still too early to predict or quantify this effect.

4.3 Public services

Broadband-based processes are essential to improve productivity in public services

Broadband-related efficiency improvement in public services cannot be evaluated the same way as in businesses. In particular, no common way of measuring the output produced by public services is used across Europe. In many cases, the output is evaluated proportional to the number of persons employed by the public services, thus implicitly considering the productivity constant.

Most public services, such as administrations, public agencies and ministries, are very similar to knowledge-intensive business services. Others, such as schools and health service providers, can be compared to service providers in the private sector. Improvements similar to productivity improvement in private companies are to be expected in the public sector through the use of online technologies.

Most public organizations at the national level are aware of the potentials of efficiency improvement through broadband technologies. The development of e-government across Europe shows that public services increasingly make efforts to provide online services to citizens and businesses. Public initiatives in the health sector and education sector also prove political will at a national level for the development of broadband-related technologies. Still, change-reluctant organizational structures often make such initiatives very difficult to implement.

4.3.1 E-government

Broadband technologies allow to reduce administrative burdens

Direct impact on companies: reduction of administrative burden

Recent focus has been put on administrative burdens in a working document from the European Commission: "Measuring administrative costs and reducing administrative burdens in the European Union" (2006) [42]. Public services require from companies that they provide quantities of information about their activity. This information is used to calculate taxes and social contributions, to provide statistics or to define economic policies: such information is essential for public services. Providing this data is a charge for companies and has been analyzed as an obstacle to competitiveness and growth in Europe. The European Commission has proposed reducing these costs by 25% in the medium term [43].

Collecting the information does not represent an administrative burden: companies collect the required financial and operational information first and foremost for their own needs. Only the transmission of this information to public services costs extra time and effort. Semi-automated online processes using broadband technologies are an essential way to reduce these costs. Reduction of the administrative burden is a concrete result of use of e-government by businesses.

The Netherlands is the most advanced European country in measuring and reducing administrative burdens for companies. The collection of measures and actions implemented by the Netherlands government to reduce the administrative burden by 25% by the end of 2007 is presented in the government communication paper "Reduction of the administrative burden for businesses" (2006) [23]. Although most of the measures are not related to broadband or the internet, the action that will induce most savings is the generalization of the XML-XBRL standard for the exchange of electronic financial documents between companies and public services. In terms of savings, 56% of the reduction of administrative burden in the Netherlands is related to online technologies.

An advanced method of measuring this burden, the Standard Costs Model (SCM) [110], has been developed in the Netherlands and used by governments in the United Kingdom, the Czech Republic, Denmark, Austria and Germany. In other countries, the study "Intra-EU differences in regulation-caused administrative burden for companies" (Kox, 2005 from the CPB, Netherlands) [79] proposes an approximate evaluation of the administrative burden. The results from the SCM analysis so far confirms that the range of estimations provided by the CPB in 2005 were reasonable: administrative burdens in Europe are supposed to be as high as € 314 bn/year (low evaluation), representing about 3% of the European GDP.

The benefits of e-government are much higher than its costs

A 25% reduction of the administrative burden in the medium term in Europe would represent savings by European companies as high as € 78 bn/year. On the basis of the Netherlands experience, € 44 bn out of these € 78 bn savings per year will be related to e-government. As a matter of comparison, e-government expenses in Europe evaluate to € 11.9 bn/year (eGEP, 2006 [28]).

A high usage rate of broadband-based processes is key to concretizing potential benefits

This evaluation of e-government-related savings assumes that 100% of the companies use e-government for the transmission of information to the public services. This is far from being the case, even in advanced countries. Increasing the usage rate of e-government is key to concretizing potential e-government savings.

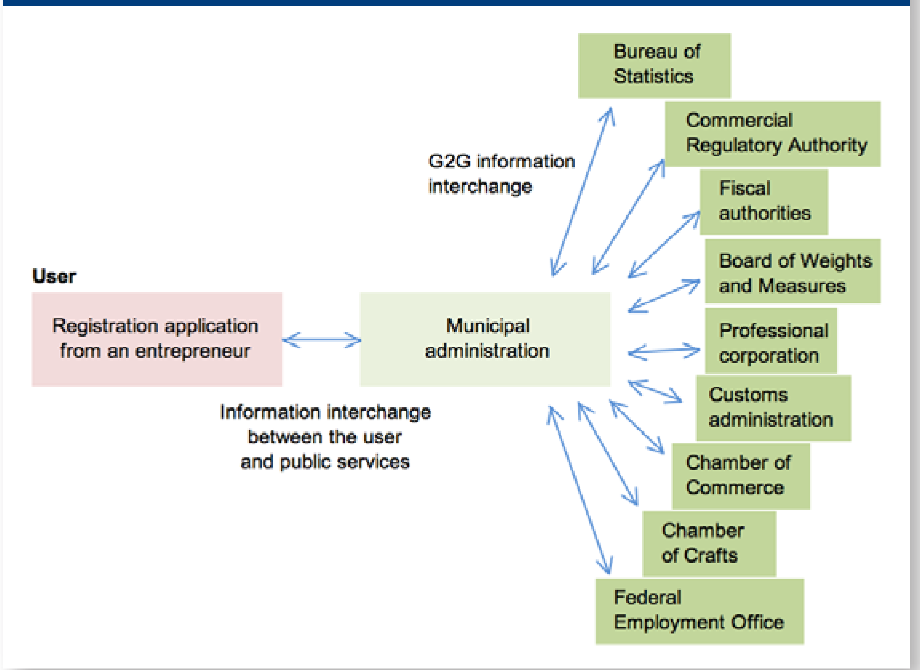
G2G interoperability: the immersed part of the iceberg

Bringing an e-government website online is one thing, but reengineering the back-office process is the most important source of efficiency improvements. The benchmarking indicators provided by Cap Gemini and the European Commission (periodic survey, 2001–2006 [13] [14]) report only superficially on the use of broadband technologies within public services, as they do not consider back-office processes. Issues related to the need of an improved measurement framework for e-government were described in the 2006 edition of the Cap Gemini benchmark [13].

Back-office flows represent 80% of the information flows in government processes

Back-office flows represent 80% of the information flows in government processes [72]. For example, according to German law, a company registration is made in the municipal administration, then transferred to no fewer than nine entities at the local, regional and national level (Figure 38). The information exchange between the user and public services in each of the 20 standard processes defined by Cap Gemini and the European Commission for the evaluation of e-government developments in Europe should be considered as an entry point to an information flow between several public services.

Figure 38 – Information flow subsequent to company registration, under German law



The potential savings made possible by the use of broadband technologies for information transfer from one public service to another (G2G) are four times as high as savings at the interfaces between public administrations and users (citizens or businesses). This potential represents about € 176 bn/year saving by public services in Europe (see Figure 39).

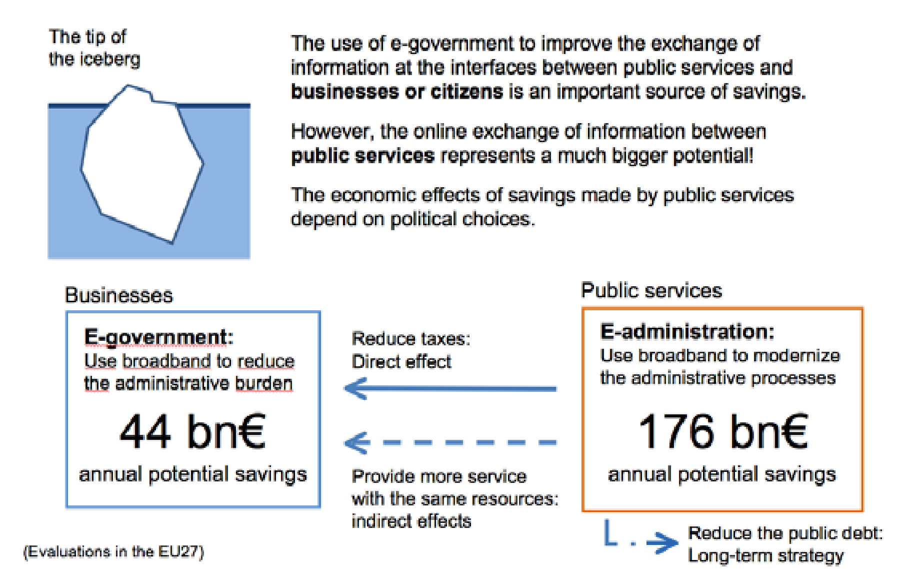
These savings are, in most cases, savings in time: public employees using broadband technologies work more efficiently. This improvement cannot easily be converted into financial savings. Thus, these savings only exceptionally lead to equivalent tax reductions or any other kind of direct contribution to the business activity in a country.

User-friendly public services contribute to competitiveness in a territory

Modern, more reactive and user-friendly public services can save much time and effort by local businesses. Public servants who are no longer assigned to repetitive, time-intensive tasks can contribute to the improvement of the service to the public and better management of non-routine tasks or can join under-staffed public services. This way, process optimization in public services can efficiently contribute to growth and competitiveness in a territory.

Companies integrate e-business technologies into their processes at a pace of 3% per year in Europe. The same 3% adoption pace for online technologies in public services would yield more than € 5.2 bn equivalent time savings through productivity improvement each year. Considering an average labour productivity of € 42 k/year in public services (European average – our calculation, based on the Eurostat national accounts database), such an additional workforce input for European public services could only be achieved through hiring 125,000 supplementary public servants each year.

Figure 39 – E-government: potential savings and economic impact



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4.3.2 E-health

Health services are information-intensive

Health service provision involves many information-intensive contacts between a large number of players: hospitals, practitioners, pharmacists, laboratories, health insurers, patients, etc. Broadband technologies could be used to exchange, securely and in real time, large quantities of multimedia information about symptoms, treatments, analyses, patient history, administrative information, or payments and refunds for the services. Great benefits can be gained from the use of high-speed internet in such an information-intensive environment involving many actors geographically dispersed.

The figures used in this section are based on the cases presented in the report "E-health is worth IT!" (eHealth Impact, 2006 [31]). This work aimed to conduct a cost–benefit analysis after the implementation of e-health applications, as they came to maturity. We use here the results of this analysis and extrapolate for these applications being implemented in the whole of Europe, by multiplying the benefits found at a local level with an adequate scaling factor. We consider only the three most representative broadband-related cases.

Electronic health insurance card

Payment for medical services requires a frequent exchange of information between health service providers and the patient's health insurer. The refund or payment process is often long and complicated, and is a burden on the service provider, the patient and the insurer.

Electronic card systems have been developed to semi-automate the healthcare insurance process. Such systems require an internet connection between the health service provider and the insurer. "E-health is worth IT!" reports on the GesundheitsCard Europa (GCE), a cross-border application between Germany, Belgium and the Netherlands. The card is used by 200,000 insured German people. We scaled the results to the European level on the basis of the population over 15 and purchasing power standards (PPS) (Source: Eurostat).

Table 10 – Net benefits, GesundheitsCard Europa (GCE)

GesundheitsCard Europa (GCE)	Germany	Europe (EU25)
Users (M)	0.2	414
PPS (index)	109.2	100
Costs/year (M €)	0.160	304
Benefits/year (M €)	0.748	1,419
Net benefits/year (M €)	0.588	1,115

A positive return on investment was achieved after only three years

According to this scaling, in a mature phase of use of an electronic health card, such a system would cost € 304 M/year to run at the European level and bring € 1.4 bn in benefits to European citizens and public services, compared to today's reference situation. As a result of these substantial savings, a positive return on investment was achieved by the GCE after only three years.

Secure messaging system between health providers

Patients are in contact with several health providers, who need to exchange information with each other. Since 1994, MedCom has developed the Danish Health Data Network (DHDN), based on the model and technologies used for Electronic Data Interchange (EDI) in other economic sectors. The system will be used by all of the general practitioners and pharmacies in Denmark by the end of 2008. The most used applications are:

- Prescriptions (from general practitioner to pharmacies)
- Discharge letters (from hospitals to general practitioners)
- Laboratory results (from laboratories to hospitals and practitioners)

Since the system is mature in Denmark, we simply scaled the results at the European level on the basis of Denmark's GDP (source: Eurostat).

Table 11 – Net benefits, Danish Health Data Network (DHDN)

Danish Health Data Network (DHDN)	Denmark	Europe (EU25)
GDP (bn €)	220	11,414
Costs/year (M €)	72.90	3,790
Benefits/year (M €)	199.74	10,384
Net benefits/year (M €)	126.84	6,594

Such a system could save more than € 6 bn per year across Europe compared to today's situation. In the case of the DHDN, return on investment was achieved in about three years.

Electronic Patient Record

Patients receive health services from several providers: hospitals, dentists, general practitioners, specialists, etc. At the moment, each of these service providers maintains a record containing information about the treatments provided to a patient, but has no or little access to the patient's record held by other health service providers. Treatment could be improved, though, if health service providers had access to the entire history of a patient's healthcare. Duplicate laboratory analysis could also be avoided.

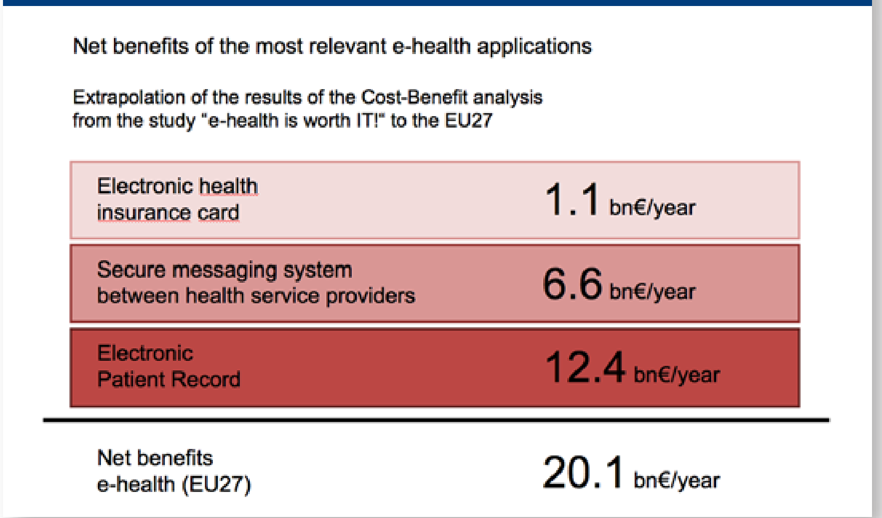
The patient becomes an active part of the healthcare process

The IZIT system, developed in Czech Republic, aims to switch such records from the health service providers to the user: the patient owns his record on IZIT's server. He can allow health service providers to access his file and add new records over the internet, though the patient cannot modify the records.

Czech Electronic Health Record System (IZIT)	Czech Republic	Europe (EU25)
PPS (index)	76.1	100
Number of utilizations (M)	30	3,296
Costs/year (M €)	47.141	6,806
Benefits/year (M €)	133.043	19,209
Net benefits/year (M €)	85.902	12,403

Table 12 – Net benefits, Czech Electronic Health Record (IZIT)

Figure 40 – E-health: potential savings at the European level



Although a lot of data is available through Eurostat about public health and epidemics, datasets concerning the use of health services are not very developed. We base our calculation here on datasets from the OECD Health data 2006, also used in the European System of Social Indicators (EUSI) from the University of Mannheim. The principal factor used to scale the benefits of IZIT at the European level is the number of visits to a practitioner. Visits to other health service providers are ignored in the calculation: according to the available statistics, the number of visits to hospitals accounts for less than 3% of the number of visits to practitioners in Europe.

4.3.3 Conclusion

The use of efficient, broadband-based technologies to exchange information between companies and public services could lighten the administrative burden by € 44 bn/year in Europe. The most important savings to be expected from the use of broadband by public services, though, is the improvement of efficiency in back-office processes involving information interchange between public services. Savings up to € 176 bn/year could be expected.

Broadband-supported technologies can ease substantially the exchange of information between health service providers, patients and other services (see Figure 40): € 20.1 bn/year could be saved by using e-health services across Europe. The problems of confidentiality and protection of the patient's private data are not a technical barrier: they can be solved by implementing the same kinds of technology as are used to exchange secure and confidential information in business environments (see, for example the description of the DHDN in the report "eHealth is worth it" [31]). However, the difficulty of reaching all practitioners and change-reluctant organizational structures in hospitals make it very difficult for new processes to be implemented in the health sector (see for example section 3.1 of the report on the modernization of the French hospitals [83]).

The calculation methodologies that we have used for public services in general (see Section 4.3.1) and health services in particular (see Section 4.3.2) are very different: the results should not be directly compared:

- Public services, despite many difficulties, are progressively implementing e-government applications across Europe. The evaluation we made corresponds to a general integration of broadband technologies into public services, at all administrative levels.
- In contrast, in health services, despite a lot of effort over the last few years, in many countries no significant progress can be observed and measured. Our approach is based on a selection of particularly relevant applications, which could be further developed over the next years.

Highly productive public services are an important competitive advantage

The use of modern information technology in public services is not essentially a matter of savings but of efficiency: well organized, highly productive public services are an important competitive advantage for companies in a country. An increased integration of IT systems in public services should provide companies with a stronger, more reactive environment and increase the competitiveness of the European territory.

4.4 E-business

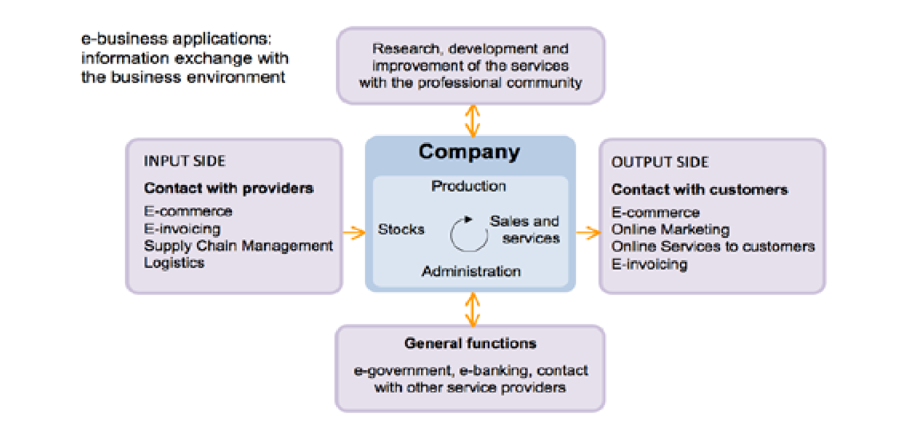
Companies use the internet to ease the exchange of information with their business environment (see Figure 41).

Broadband benefits to companies in all activity sectors

All companies exchange information with their business environment: providers, customers, banks, public services, etc. Consequently, broadband-related productivity improvements are not restricted to companies in a particular economic sector: companies in all activity sectors would potentially benefit from using e-business.

As described in Section 2.2.2, most online technologies can be used over narrow-band internet for episodic use. However, broadband is essential for intensive integration of e-business technologies into a company's processes, as described in this section. Besides broadband connectivity, the adoption of online technologies strongly depends on non-technical factors, as described in Section 2.1.2. Factors driving broadband-related productivity improvements are analyzed in detail in Section 4.4.2.

Figure 41 – E-business: information exchange with the business environment



How do we define e-business?

"E-business" is more a commercial term than a technical one. There are two definitions of e-business in use:

- ICT-based business tools, including enterprise databases (ERPs), office software and intranet and internet tools. This definition is used, in particular, in e-business-w@tch, a reference research programme supported by the European Commission concerning the use of ICT in the European companies.
- internet-based business tools, including enterprise websites, e-commerce and other online services (Source: Encarta encyclopaedia).

Only the second definition is related to broadband internet and is considered for this study.

4.4.1 The effects of e-business depend on the specific economic sector

Beyond basic use, the benefits of broadband depends on the specific economic sector

Any company can benefit from e-business services without advanced IT skills. Basic uses are sufficient justification for a company to have a broadband connection:

- Use e-banking and e-government
- Search for information about providers, search for new products over online marketplaces
- Exchange e-mails with customers and providers

Beyond this basic use, choosing the right strategy to use a website and provide online services depends on the company's activity sector and requires understanding of the internet business.

Broadband internet eases the exchange of large quantities of information in real time between geographically distinct entities. For a company willing to integrate online technologies into its processes, the decisive question is: which part of the company involves intensive exchange of information with the outside?

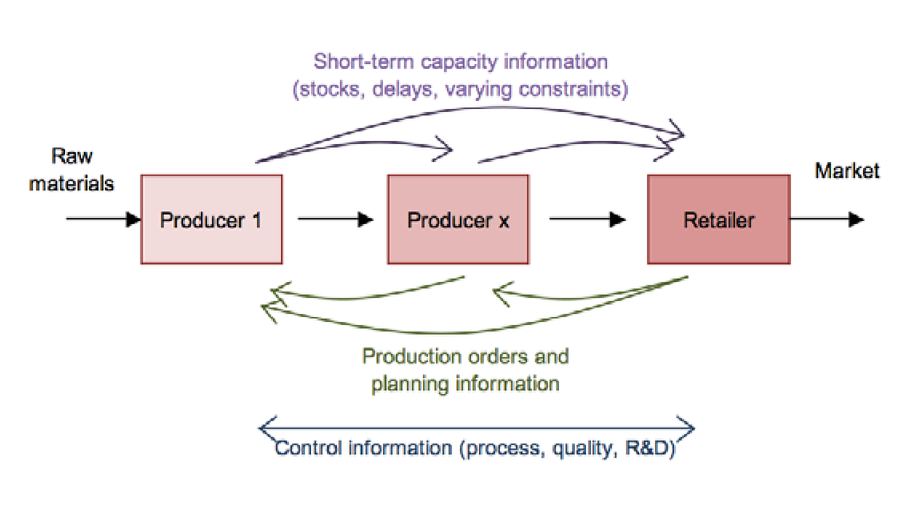
In the manufacturing sector, the exchange of information along the supply chain is essential

For companies in the manufacturing sector, the integration into a supply chain is decisive. It involves real-time information flows with providers and customers, sometimes at several degrees of network integration (the customers of the customer, etc.). In the services sector, sales and customer relations are the most information-intensive contacts with the outside.

Supply-chain integration in the manufacturing sector

Supply-chain integration is the transfer, along a chain of providers, of information in both directions (see Figure 42).

Figure 42 – Integrated supply chain (simplified)



A large part of the B2B information transfer is made without the use of websites: Electronic Data Interchange (EDI) standards, now extended by XML standards, are used to exchange automatically processed documents such as purchase orders, invoices or banking transactions. These specialized messaging systems use the same technology and infrastructure as the internet.

Small companies are slow to adopt broadband technologies

Small companies are slow to integrate advanced information management systems, such as Enterprise Resource Planning systems (ERP), into their processes. This lack of ICT integration can be a barrier to their participation in complex supply chains. The development of the internet allows some service providers to propose ERPs "as a service": without installing any software on his own system, a small entrepreneur can connect over the internet to a website with all the functionality of an ERP. He pays for the service on a fully scalable subscription basis depending on the number of his employees. The hardware, software and associated services are managed remotely by IT professionals.

The importance of broadband availability in the selection of a parts provider already impacts small and innovative companies in the mechanics sector, where supply chain integration is most developed. Other industrial sectors with a large proportion of small and medium businesses are progressively put under the same pressure: the paper industry, chemicals, the whole food products chain (including farmers) and the production of construction materials.

Undoubtedly, integration of the supply chain represents the most important use of the internet for manufacturing companies. It does not only save processing and transfer time along the supply chain, but also radically increases competitiveness by reducing stock levels, optimizing logistics and improving the quality of the final products.

Customer relations in the services sector

In the services sector, online customer relationship contributes to productivity improvement

Customer relations is a much more important part of a company's activity in the services sector than in the manufacturing sector. It represents on average 50% of a service company's activity (including sales). Efficiency improvement using broadband technologies for customer relationships are essential to the competitiveness of the service companies.

The use of the internet to provide services is as varied as the services sector itself. The following description of broadband applications lists the most relevant examples of services delivered through the internet but is in no way a description of all the possible uses.

- Business-to-Consumer (B2C) e-commerce
  The adoption of the internet for B2C services and e-commerce depends firstly on internet penetration in households. It is also very sensitive to individuals' readiness to transmit credit card information over the internet. Despite fast growth, B2C e-commerce still represents only about 25% of the overall e-commerce in western Europe, the rest being Business-to-Business (B2B) e-commerce. For this reason, B2C e-commerce tends to be considered less important than B2B online transactions.
  This opinion should be viewed with caution: many individuals use the internet to search for information before they actually purchase an item or a service in a normal shop. The internet is an important part of the purchase decision. The development of e-commerce in the UK shows that as soon as the public become confident in both the technology and the information available online, B2C e-commerce booms (it increased 24% between 2005 and 2006) [98].
  Having a shop online is not too expensive for small companies: eBay and Amazon have long offered sales platforms for professionals over the internet. Some web service providers also offer a standard fully functional online shop to be integrated into the company's website for less than € 1000 investment plus a small monthly fee.
- Self-service websites
  Service organizations, such as banks, utilities, public services and travel agencies, use counters or call-centres to provide account management, payments or information services to their clients or citizens. This kind of service has some drawbacks: it has limited opening times, people often have to wait, and it is personnel-intensive.
  Many services are now available directly to the user on the service provider's website. E-banking, subscription management, online travel agencies and some e-government websites are examples of these. These online self-service counters save time for the user and the service provider, accelerate issue processing and reduce the number of errors.
- Remote services
  Modern operating systems allow operators to have remote access to a workplace computer for assistance, administration or maintenance operations. With such remote access, a technical operator, instead of going to his customer's location for a short intervention, can solve his client's problem over the internet as if he were sitting in front of the customer's computer. The kind of innovative technology that can be associated with videoconferencing is hardly possible on an ADSL connection due to the low upload bandwidth (<200 kbit/s in most cases). The development of an infrastructure with higher capacity would allow the development of a whole new range of user-friendly remote services for individuals and professionals.

As the previous examples show, using the internet to manage customer relationships is not about dehumanizing the relationship between the service provider and the client. On the contrary, small companies making extensive use of these technologies appreciate being able to provide a more user-friendly service to their customers and have more time to improve the quality of their relationship. "I am not a good computer user. Contact with customers has been most important to me, since the beginning", says Patrick, founder of a family-run e-commerce company in Cornwall. "However, I do not feel frustrated with the internet. We use the website to display our catalogue and receive orders, e-mails to deal with routine tasks, and telephone calls to deal with particular cases or when we need a more personal contact with the customer, which is always very important."

Knowledge-intensive business services

The KIBS sector is one of the most dynamic activity sectors

Knowledge-intensive business services (KIBS) have been recognized both by the European Commission and the OECD as a quickly growing source of innovation, employment and economic activity [66]. The development of KIBS is closely linked to information technologies.

According to the European Foundation for the Improvement of Living and Working Conditions, a European Union body, KIBS include the following service activities [50]:

NACE division 72: Computer and related activities	
72.1	Hardware consultancy
72.2	Software consultancy and supply
72.3	Data processing
72.4	Database activities
72.5	Maintenance and repair of office, accounting and computing machinery
72.6	Other computer-related activities
NACE division 73: Research and experimental development	
73.1	Research and experimental development on natural sciences and engineering
73.2	Research and experimental development on social sciences and humanities
NACE division 74: Other business activities	
74.11	Legal activities
74.12	Accounting, book-keeping and auditing activities; tax consultancy
74.13	Market research and public opinion polling
74.14	Business and management consultancy activities
74.15	Management activities of holding companies
74.20	Architectural and engineering activities and related technical consultancy
74.3	Technical testing and analysis
74.4	Advertising
74.5	Labour recruitment and provision of personnel
74.8	Miscellaneous business activities n.e.c.
74.81	Photographic activities
74.84	Other business activities n.e.c.

Table 13 – Knowledge-intensive business services: definition based on NACE classes (see associated notes in the original document)

Companies in the KIBS sector provide services to other businesses in fields where external knowledge is required: they work intensively with information. For example, an engineering and design bureau receives information (functional specifications) from their customers and creates new information (construction plans and digital prototypes). The value produced by the KIBS sector is information, similar to goods in other parts of the economy. The telecommunications infrastructure is essential to their activity, exactly as transport infrastructures are essential in the rest of the economy.

KIBS work intensively with information

Innovation in the KIBS sector is crucial. For example, an independent accountant able to provide semi-automated, self-service functions over a website is able to be "closer" to his customers by providing ubiquitous, 24/7 services (see also the case study from the e-business-w@tch database: advo 24 [24]). Physical encounters between the service provider and his customers can be used for more important issues, increasing the efficiency of both companies. In this example, the technical development (a web application) is secondary, whereas the real added value is in process innovation: routine contacts between the service provider and the client take place over the internet. This flexible environment and perpetual innovation is favourable to small businesses, able to adapt their structures more dynamically than large organizations.

Innovation is crucial

KIBS represent an increasing share of employment and economic activity in Europe. In contrast to industrial activities, they do not require the workforce to be concentrate in a particular location: some of these activities are suitable for rural areas and can be developed outside of urban centres. Due to the importance of the telecommunications infrastructure for business models in the KIBS sector, areas with no broadband infrastructure cannot benefit from this economic sector's dynamism and growth.

KIBS can develop in rural areas where broadband connectivity is available

4.4.2 Quantifying the impact of broadband on productivity at the company level

Many case analyses of the impact of e-business have been done so far, in particular by IT companies selling e-business solutions and by research laboratories in management sciences. The methodology used for these case analyses vary strongly from one case to another, in particular because of essential differences in the activities of the companies which have been analyzed.

Methodological approaches vary strongly from one case to another

The assessment of the impact of e-business on productivity made in this study occurs in two steps:

1. Evaluation of the impact of e-business adoption in a company in a general case
2. Evaluation of the impact of e-business at a macro-economic level, by combining the precedent results with e-business adoption statistics.

This section of the report deals with the construction of a general model for the evaluation of productivity improvement in a company integrating e-business technologies into its processes (step 1). This analysis is based on other studies and available literature. In order for the model to be usable for statistical calculations at the European level, the

A general model for the evaluation of broadband-related productivity improvement input variables are chosen among indicators from the "Community survey on ICT use in enterprises".

The following factors influencing the impact of e-business on productivity were considered:

- economic sector of the considered company
- nature of the e-business technology adopted by the company
- functional structure of the company
- size of the company
- integration intensity of e-business technologies into the company's processes.

Impact on productivity at the company level: available results

Results from reference studies are coherent one with another

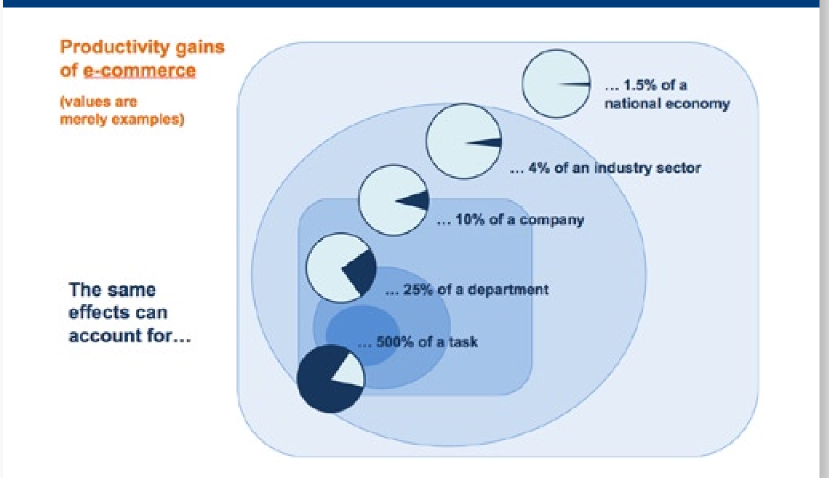
Several analyses have been done so far to establish a quantitative link between broadband development and productivity. Notably, the work from Atrostic and Nguyen at the US Bureau of Census [4] brings out the impact of ICT technologies on productivity at the company level. These researchers have spent several years refining their methodology for the analysis of a dataset created in 2000 over more than 25,000 production plants in the US, in the manufacturing sector.

Using two different methods of measure, Atrostic and Nguyen find correlations of up to 3.85% and 6.07% between labour productivity improvement and intensive use of e-business at the company level, with a good level of significance.

A similar methodology was applied by Rincon, Robinson and Vecchi at the National Institute of Economics and Social Research (London) [108] on a dataset concerning the use of e-commerce that was raised among firms in 2001 in the UK including the services sector:

- The impact of e-commerce on productivity is roughly twice as high in the services sector as in the manufacturing sector.
- On average, 90% of the firms in the services sector improve their productivity by 9.8% when using e-commerce.

Figure 43 – Impact on productivity: importance of the level of observation



These results are in line with the results from the e-business-w@tch survey [25] claiming that the impact of e-business on productivity depends on the economic sector. The e-business-w@tch survey, however, is mostly limited to the manufacturing sector.

Does broadband allow 500% productivity improvement? 20%? 5%? Or only 1%?

- How should we evaluate the impact of broadband on productivity? Different evaluations are not necessarily contradictory but the level of observation matters (see Figure 42).
- The implementation of an online shop could multiply by six (increase by 500%) the productivity of the "remote sales" department of a company: the same personnel can deal with many more orders than before.
- If the "remote sales" department only represents 5% of the "sales department" of the company, we could consider that the online shop has improved the productivity of the "sales department" by 25%. We are still considering the same effect and the same productivity improvement as in the previous point, but we have broadened out our level of observation. The two evaluations of this effect (500% and 25%) look very different but, in fact, they are not contradictory.
- If the "sales department" accounts for 40% of the activity of a company, the use of e-commerce has improved the productivity of the company by about 10%.
- If all companies in an economic sector could improve their productivity similarly by using e-commerce, but only 40% of them adopted e-commerce as part of their processes, then the productivity improvement for this business sector would be limited to 4%.
- If the same calculation were applied to all economic sectors at the level of the national economy, then productivity improvements could represent an improvement of 1.5% or 1% of the GDP.
- Confusion between the different levels of observation keep misunderstandings alive in evaluation of the impact of IT on productivity. For an average auditor, it is difficult to believe that an estimation of 500% and an estimation of 1% may seriously provide a measure of the same effect. The credibility of such evaluations is severely impacted, although they may both be correct.

Impact on information-intensive functions of a company that involve contact with outside bodies

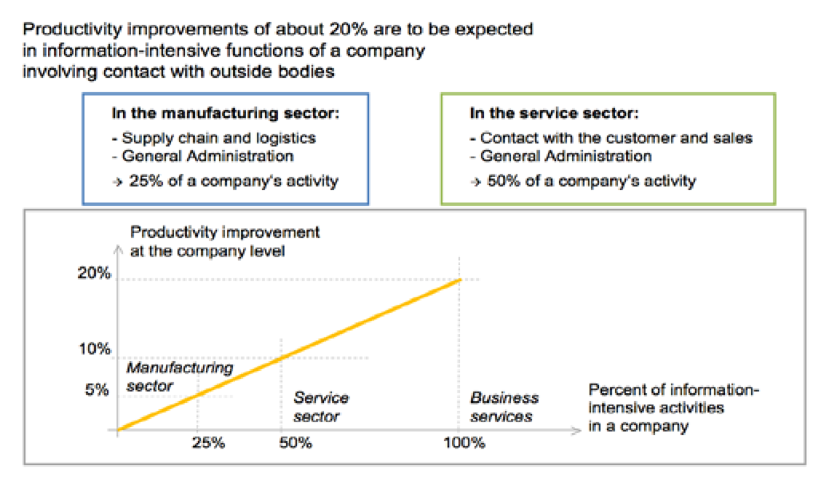
Focus on information-intensive functions of a company

E-business is a way for a company to exchange information with its business environment. Its direct impact is limited to the information-intensive functions of a company that involve contact with outside bodies. All companies exchange information with their environment, at least with public services and banks. The share of such functions in a company's activity has a decisive influence on the impact of e-business on the company's productivity.

In the manufacturing sector, these functions (general administration, supply and sales) represent on average about 25% of a company's activity. In the services sector, general administration and customer relationships can be considered to represent 50% of the activity. In the KIBS sector, all activities of a company are knowledge-intensive and require an exchange of information with outside bodies.

In the business services sector (KIBS), internet-based processes are strongly integrated into companies' activity. A comparison between today's internet-based processes and the former processes hardly makes sense, because internet did not only change the way information is exchanged, but also the nature and quantity of the information that can be exchanged with outside bodies. When asking managers for the impact of the internet on their team's productivity, the benefit is, in most cases, clear although it seems not to be quantifiable: „I think we often don't realize ourselves how beneficial it is – we probably now tend to take it for granted that it's always there!" [76].

Figure 44 – The link between broadband-related productivity improvement and economic sector



According to the analysis that was made in the manufacturing sector and the services sector on the basis of statistical data, the impact of broadband on productivity in knowledge-intensive activities involving contacts with outside bodies is 20%. The average broadband-related productivity improvement in this kind of activity is considered constant and equal to 20% for the following steps of the analysis (see Figure 44 and Table 14).

Table 14 – Broadband-related productivity improvement by economic sector

Economic sector	Source of the evaluation	Evaluated impact of e-business on productivity at the company level	Share of information-intensive activities involving contact with outside bodies
Manufacturing	Atrostic and Nguyen	~5%	~25%
Services	Rincon, Robinson, Vecchi	~10%	~50%
KIBS	Specialist experience	~20%	100%

The role of e-business intensity

The nature of a company's activity, here represented by the share of information-intensive functions in a company's activity, is not the only factor influencing the impact of e-business on productivity. The second important factor is the level of integration of e-business into a company's processes.

Companies progressively integrate e-business into their processes

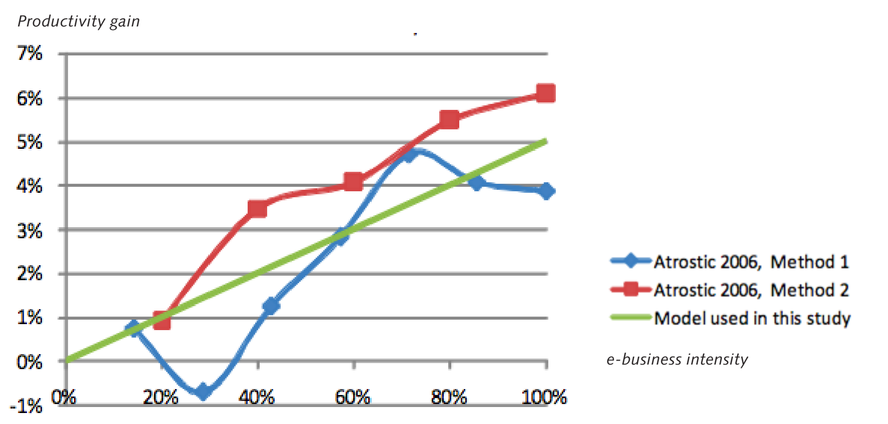
The division between companies using or not using e-business is not binary (yes/no); rather, each company progressively integrates e-business technologies into its processes. Typically in the services sector, they do this first by using the internet to search for information about providers, second by using e-banking and e-government, third by having a website, then by integrating an online shop into the website, etc.

The effect of e-business technologies is cumulative

The analysis from Atrostic and Nguyen [4] shows that the effect of e-business technologies is cumulative: each new e-business technology used increases the company's productivity. In the case of a complete integration of broadband technology into the company's processes, the productivity of the company, compared to the initial situation, has improved up to the values evaluated above (see Table 14). The evolution of the impact on productivity between the initial situation and complete e-business integration can be considered linear.

Figure 45 represents this linear model together with the results of two different analyses from Atrostic and Nguyen on the evolution of the impact on productivity related to a progression in e-business integration in a company. The state described here as "100%" corresponds to the most advanced e-business intensity surveyed in the dataset. It is important to keep in mind that there is, in reality, no final state of e-business implementation in a company: integrating information technologies and the internet into a company's processes is a continuous movement towards innovation, information intensity and efficiency improvement.

Figure 45 – The impact of e-business intensity on productivity in the manufacturing sector



The composite indicator on the use of online services (see Section 2.1.3) takes into account the intensity of use of online services in companies. For example, a company using e-banking and e-government but not using the internet to receive or provide after-sales services would only account for 50% in the first category (online services through a website).

The role of the size of the company

Small companies are slower to integrate e-business into their processes (see Section 2.1.2). However, there is no consensus on the question of whether or not the size of a company has an influence on the impact of e-business on productivity.

Broadband allows tailored services for SMBs

On the one hand, heavy investment in hardware, software and web development are prohibitive for small companies. Two factors are now coming to maturity and making this problem less important:

- The improvement of the broadband infrastructure has allowed web service providers to provide on-demand, tailored, user-friendly services, also known as "software-as-a-service". These models are particularly well adapted to provide IT services to small companies.
- Shared software development between several companies is slowly coming to maturity, in the form of open-source software. Investment costs are transformed into service costs, allowing web service providers to progressively apply affordable service-oriented price models to advanced technologies. Incentives to participate in open-source development for companies and public services will further reduce the entry barrier to the knowledge society for small and medium companies (SMBs).

Both these factors enable the development of scalable, tailored solutions that can be implemented quickly in small companies.

Complicated, highly hierarchical structures in large companies are poorly adapted to process and service innovation: due to a lack of flexibility, the costs of change management are high. On the contrary, small companies can easily integrate e-business technology into their processes.

The case studies database of e-business-w@tch [24] provides numerous examples of SMBs in all economic sectors having successfully integrated internet-based information systems into their processes. The examples of Fiorete (textilebusiness.it, in the textile industries in Italy), Bygg og Industrieservice A/S (in the construction sector in Norway), DWS-Online (e-learning for SMBs in Germany) and Centralia (business services for the food and beverage sector in Italy) are notable.

These cases of SMBs having successfully grown their business after having implemented different kinds of e-business technologies show that the lack of e-business adoption among SMBs is not related to the technology but to a lack of awareness of the benefits of internet. Small businesses do not realize that they are competing with regional or international companies able to provide a better service over the internet than local firms can provide locally.

E-business is not less profitable for small businesses

In conclusion about the influence of the size of a company on the impact of e-business on productivity, we argue that:

- E-business is not less profitable per se for small businesses. The offering of scalable web services is progressively becoming more adapted to their needs and makes the handicap of their small scale disappear.
- E-business use in SMBs suffers from high awareness barriers. Unless managers receive advice and support in developing their internet strategy, these barriers will remain an obstacle to e-business adoption. Professional organizations are in the best position to provide this kind of support. They have a responsibility in the adoption of e-business by SMBs.

4.4.3 The impact of e-business at the macro-economic level

Broadband penetration in companies

Broadband connectivity: the demand from companies is high

The "Community survey on ICT use in enterprises" provides indicators of the penetration of broadband into companies by country, economy sector and size of the company (column 1 in Table 15). The evolution of these indicators between 2004 and 2006 allows for the calculation of the percentage of companies subscribing to broadband each year (annual adoption rate, column 2 in Table 15). Broadband penetration among companies is quickly progressing all over Europe:

- Broadband penetration among small companies is very high (71.5%) and is still quickly growing (14.2% per year), while broadband penetration among large companies has reached saturation (95.4%).
- Broadband penetration in the services sector (78.2%) is significantly higher than in the manufacturing sector (70%).
- Broadband penetration in the less advanced broadband countries is much lower than in the developed knowledge societies, although this gap is diminishing. The large western European countries have been very successful over the period 2004–2006 in developing broadband penetration among companies (13.6% per year).

Obviously, policies aimed to make broadband available in businesses are successful. The demand from companies is high, even among small and medium firms.

Broadband penetration (connectivity) 1 → 2

EU27 broadband connections (% of enterprises, source: Eurostat)	Broadband penetration rate (2006)	Broadband annual adoption rate (2004–2006)
EU27 average	74.5%	+13.2%
By size of the company		
Small companies (<50 empl.)	71.5%	+14.2%
Large companies (>250 empl.)	95.4%	+4.9%
By economic sector		
Manufacturing sector	70.0%	+14.9%
Service sector	78.2%	+12.6%
Business services (K)	84.9%	+11.7%
By country group		
Less developed knowledge societies	52.3%	+12.7%
Quickly developing	66.4%	+8.4%
Large industries	78.7%	+13.6%
Advanced knowledge societies	82.3%	+9.3%

Table 15 – Broadband penetration in enterprises by size, economic sector and country group
Sources: Community survey on ICT use in enterprises, our calculations

Online services

As previously stated at the micro-economic level, having a broadband connection in a company does not have an impact on productivity unless online technologies are integrated into the company's processes to improve the exchange of information with the business environment.

At the macro-economic level, the composite indicator of the use of online services (introduced in Section 2.1.3 of this study) takes into account both e-business penetration and e-business intensity among companies. It can be calculated for a particular economic sector and a particular group of countries, or by size of the company (column 1 in Table 16). The online services included in this indicator are e-banking, e-government, online after-sales services, e-commerce, access to a company's IT system from outside the company, etc. (see Section 2.1.3).

Use of online services: inequalities are growing

By comparing values from the "Community survey on ICT use in enterprises" in 2004 and 2006, it is also possible to evaluate the progression rate of the e-business indicator over this period (column 2 in Table 16). The results show that inequalities are growing:

- The use of e-business technologies in small companies (fewer than 50 employees: 21.4%) is still significantly below e-business use in large companies (more than 250 employees: 37.5%). This gap has been growing between 2004 and 2006.
- Companies in the services sector, in particular business services, use more e-business technologies than in the manufacturing sector. This gap has been growing wider between 2004 and 2006.
- Companies in the most advanced knowledge societies use e-business twice as much as in the less advanced countries. This gap is still dramatically growing. The use of e-business in the quickly developing knowledge economies is almost as high as in the large western European countries.
- Overall in Europe, the use of online services increases by about 3% per year. This is an essential indicator of Europe's transition to a knowledge society: efforts should be made to raise this adoption rate.

Use of online services

EU27 e-business (% of enterprises, source: Eurostat)	(1) Online services composite indicator (2006)	(2) Online services annual adoption rate (2004–2006)
EU27 average	23.1%	+3.0%
By size of the company		
Small companies (<50 empl.)	21.4%	+2.8%
Large companies (>250 empl.)	37.5%	+4.1%
By economic sector		
Manufacturing sector	20.1%	+2.7%
Service sector	25.6%	+3.2%
Business services (K)	26.6%	+2.9%
By country group		
Less developed knowledge societies	14.4%	+1.8%
Quickly developing	21.5%	+3.1%
Large industries	22.6%	+3.3%
Advanced knowledge societies	29.3%	+4.1%

Table 16 – Use of online services in enterprises by size, economic sector and country group

In each economy sector considered, the impact of e-business on productivity has been assessed at the company level (see Table 14). The annual contribution of e-business to productivity growth (column 3 in Table 17) is the product of the micro-economic impact of e-business on productivity with the annual e-business adoption rate (column 2). By combining the impact of e-business on productivity in each economic sector with the respective shares of the manufacturing sector, the services sector and the KIBS sector in a country's economy, the macroeconomic impact of e-business can also be calculated for each country. Aggregated results for each country group defined in Section 2.2.1 are presented in Table 17.

According to the model, the annual productivity improvement due to e-business is less than 1% per year in all cases and is equal to 0.29% per year at the European level.

Use of online services and productivity improvement

EU27 e-business (% of enterprises, source: Eurostat)	(1) Online services composite indicator (2006)	(2) Online services annual adoption rate (2004–2006)	(3) Annual productivity improvement
EU27 average	23.1%	+3.0%	+0.29%
By size of the company			
Small companies (<50 empl.)	21.4%	+2.8%	+0.29%
Large companies (>250 empl.)	37.5%	+4.1%	+0.44%
By economic sector			
Manufacturing sector	20.1%	+2.7%	+0.14%
Service sector	25.6%	+3.2%	+0.32%
Business services (K)	26.6%	+2.9%	+0.58%
By country group			
Less developed knowledge societies	14.4%	+1.8%	+0.16%
Quickly developing	21.5%	+3.1%	+0.26%
Large industries	22.6%	+3.3%	+0.33%
Advanced knowledge societies	29.3%	+4.1%	+0.41%

Table 17 – Use of online services and productivity improvement in enterprises by size, economic sector and country group

The lack of awareness is currently the critical factor

The availability of broadband connectivity in companies is growing much faster than the adoption of e-business services. The lack of awareness of the benefits of online technologies is currently the critical factor in the broadband-related improvement of productivity at the macro-economic level, in particular in small companies (see Section 4.4.2: the role of the size of the company).

4.4.4 Conclusion

The use of e-business technologies has a positive impact on a firm's productivity. This impact depends on the intensity of information in the company's activity. In the manufacturing sector, productivity improvements of 5% can be expected, principally due to supply-chain integration. In the services sector, the use of the internet to provide online services to customers may increase the average productivity of European firms by 10%.

The current pace of e-business adoption, 3% per year in Europe, yields an annual productivity improvement of 0.25% per year at the macroeconomic level. This effect could be boosted by a faster adoption of online services, in particular in SMBs.

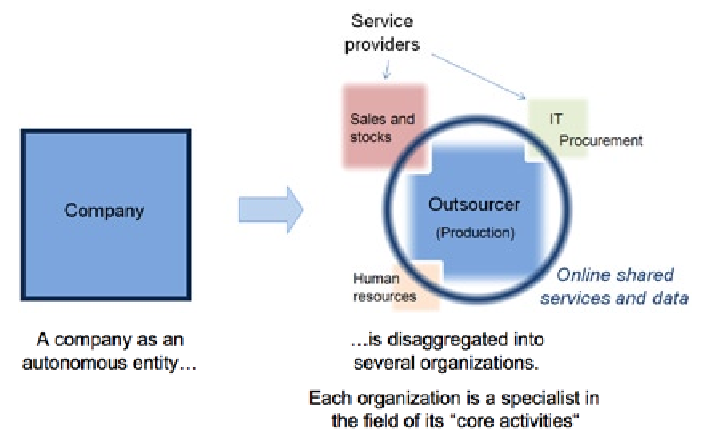
4.5 Outsourcing and business networks

In the 20th century, information on paper or analogue support (magnetic band or film) was difficult to copy, transport or integrate into automated systems. The dominant organizational model of many industrial companies was adapted to this constraint of "slow information": choices, development strategies and management of the different functions of a company were made centrally.

Broadband changes organizational structures

In a society where large quantities of information can flow quickly between companies, other organizational structures become more efficient. Companies tend not to work as "autonomous entities" any more, but rather buy services from other, more specialized providers (see Figure 46). The provision of services is not only a hierarchical relationship: both client and provider may take initiatives, innovate, give new possibilities to their business partner. Such distributed structures would not be possible without broadband infrastructures able to bring all participants of the business network close to one other in a virtual space.

Figure 46 – A company: from an autonomous entity to a network of specialized organizations



The analysis of the productivity improvements due to organizational changes in business environments requires a focus on the relationship between companies. The following model analyzes the productivity improvement due to business-process outsourcing. This kind of relationship between companies is strongly conditioned by the presence of a broadband link between customers and service providers.

Outsourcing and off-shoring

- **Outsourcing** is the decision for a company to entrust part of its activities (production of goods or services) to another company. In many cases, the supplier is located in the same geographic area as the outsourcer. The supplier may take over some production facilities and employees that were originally part of the outsourcing company.
- **Off-shoring** is the decision for a company or an investor to move some activity to another country, in general to a lower-cost country. The off-shored facility may still belong to the same company. In this case, the activity is off-shored, but not outsourced.
- **Business-process outsourcing (BPO)** is the decision for a company to outsource some of its knowledge-intensive activities to another company. Some examples of BPO activities are IT management, human resources management, accounting, procurement and legal services [60]. The provision of these services requires high competencies: the outsourcing decision does not only aim to reduce costs but also to benefit from the service provider's competencies. This kind of outsourcing requires intensive exchange of information between the outsourcer and the service provider. Its development is strongly related to the development of broadband telecommunications.

Examples of innovative networks and process improvement in customer–supplier relationships

- The aeronautics industry has been a pioneer in the development of collaborative virtual spaces, where several partners from different regions of the world can work on the same digital prototype. Technical innovation on the prototype is not only due to the work of the main company (the assembler) but takes advantage of the innovation potential from each parts provider. Synergies and cross-pollination of ideas between all specialists working on the same prototype in real time increases this innovation potential (see the case study on Dassault from the e-business-w@tch [24] and the analysis of the supply-chain by Boeing [123]). Other industrial sectors, such as the automotive industry, also develop ecosystems where the leading assembler or OEM takes advantage of process improvements and initiatives pushed by its suppliers (see the case study about SupplyOn from the e-business-w@tch [24]).
- Not only parts providers but also business services providers are in a position to introduce constant improvement into the processing of information flows. These improvements do not only raise the productivity of the considered company, but also of its customer companies. Notable examples from the e-business-w@tch case study database [24] are advo24 (a law office) and Heistermann (facility management). Netpack from Cornwall (see Section 3.2.5) implemented online catalogues and e-payment functionality for customers that were not in a position to initiate such process innovations themselves. Crucial process improvements are introduced by providers of procurement services (for example, webEDI), human resources management services (for example, e-learning) and accounting services (for example, XML standards for the exchange of data with banks and public services).

4.5.1 Examples of outsourcing in a small or medium company

In the knowledge society, the production of business services increasingly requires specialized competencies and dedicated technical tools. Companies of all size consider entrusting such activities to specialized professionals, instead of producing these services internally. Broadband has made possible the transfer of internal business services to other companies.

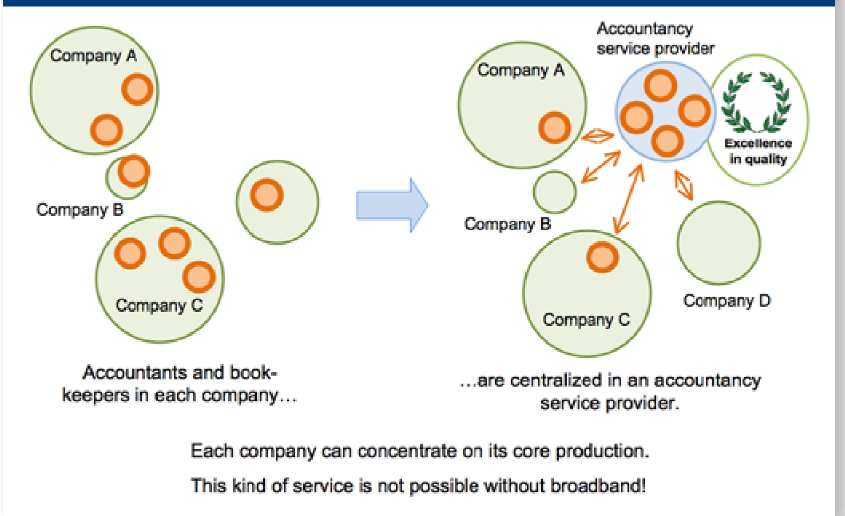
The following examples illustrate how a company can outsource some processes to improve its competitiveness:

- Procurement: small and medium companies are too small to benefit from price reductions on large quantities of raw materials. A procurement service provider can bundle their orders, find the best provider, and organize the regional logistics to distribute the raw materials to its clients. Storage of materials at each customer's site is reduced, as the risk of shortage is managed at the regional level. The service provider and its clients use broadband to communicate on orders, planning, logistics, invoices, the choice of providers, etc. See also the case study from the e-business-w@tch database: Centralia [24].

- Accountancy: accountancy and human resources management are key elements of the modern management of a company and increasingly require specialized competencies which are not available to small and medium companies, or when a new business is created. Accountancy service firms (see Figure 47) provide their clients with up-to-date skills and technology, and continuously adapt their methods to the new requirements of their profession. They may be very small local firms of a few employees, providing administrative services to companies and micro-companies in the same region. For good communication and confidence between the client and the service provider, regular contact in person may be preferred. However, most everyday tasks can be achieved by e-mail, on the phone or over secure internet links between the service provider and its clients.

- Research activities: most small and medium companies cannot afford to maintain modern laboratories and senior researchers. In contrast to in-house laboratories, research institutes are not a fixed asset for their clients, which makes them much more flexible: they are able to conduct parallel pieces of research in more intensive research campaigns or to interrupt the research program, depending on their client's R&D strategy. Intermediary results, research documents and strategies can be securely and instantly exchanged over the internet between the laboratory and its client, thus solving the problem of the distance between the client and the researchers.

Figure 47 – Example of labour specialization: accountancy service provider



These examples show that outsourcing is not only about reducing the workforce costs: the decisive factor is the adoption of flexible organizational structures, where each player shares part of the responsibility. Such structures are naturally pushed towards higher competencies and efficiency. For example, a procurement service provider is responsible for the choice of suppliers, for commercial negotiations, for the use of modern technologies to ease the transfer of information with his clients, and for an efficient logistics management. He has to be competent in order to satisfy his clients. The latter, having delegated the optimization of the procurement activity, can enjoy the results and concentrate on issues more closely related to their core activity.

Outsourcing improves efficiency and flexibility and fosters innovation

By bundling workforce and competencies, outsourcing may reduce the number of employees needed to achieve a function, compared to the employees being spread in several companies. On the other hand, outsourcing is a great advantage in innovative sectors of the economy or for micro-companies: the flexibility allowed by service providers may be vital for the creation or development of new activities. By trying to achieve excellence in the provision of a particular service, specialized service providers often introduce new methods, technology-based tools or new kinds of service. Employment lost on the one hand by the concentration of the activity can be compensated for on the other hand by increased employment in innovative companies or service innovation from the service provider itself.

Outsourcing increases the need for strong and inclusive social structures

Outsourcing is a further step in the division of labour, in the sense that Adam Smith considered a qualitative increase in productivity. Labour specialization is generally limited by the induced complexity of the production process. The development of information technology and broadband telecommunications concretely reduced the costs of complexity management, thus allowing a further step forward in the division of labour. Along with this change, it should be remembered that an improved division of labour necessarily increases the need for strong and inclusive social structures, social protection and cultural communities.

4.5.2 Quantifying the impact of business-process outsourcing on productivity

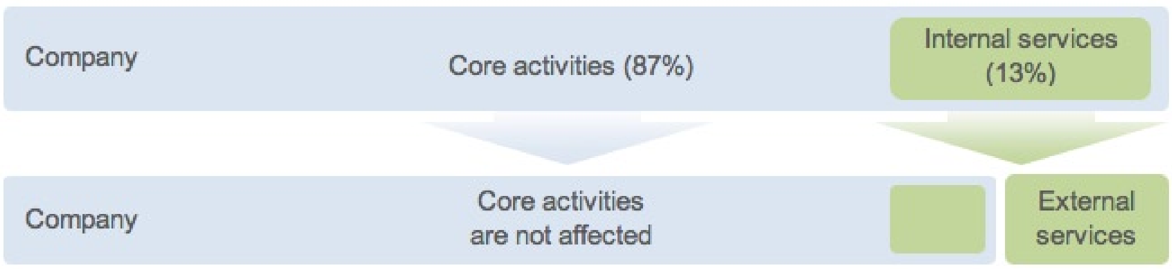
In contrast to e-business, very few statistics are available on the use of BPO by enterprises.

Displacement effect

Core activities are not affected

According to the report published by Abramovsky and Griffith [1] in 2005 on their analysis of a dataset recorded in the UK in 2001–2002, business services represent about 13% of the total output of companies in any economic sector (see Figure 48). This means that 13% of the output of a manufacturing company consists of business services, the rest being manufacturing. After outsourcing its business services, the company uses the same services, but only part of them are produced inside the company.

Figure 48 – Displacement of activity from other sectors of the economy to the business services sector



Not all of the business services in a manufacturing company can be efficiently outsourced: a company will always have administrative personnel and will produce business services internally, although not as much as before. Abramovsky and Griffith also find that the internet and ICT substantially increase the use of outsourced and off-shored business services.

Impact of displacement

Workers in the business services sector have a higher level of education than in the rest of the economy [66]. The high general level of education in Europe, including in many

Eastern European countries, represents a comparative advantage for the provision of business services in the European Union, compared to other regions of the world.

A displacement towards high value-added activities

There are huge differences in labour productivity between the different economic sectors. The statistics in Figure 49 present the average value added per person in each economic sector. They are sensitive to variations in the average time worked, which explains low values, for example, in the tourism sector (many seasonal jobs) and activities of households (many part-time jobs). Still, activities in the business services sector appear to produce about twice as much value per person as the average.

Figure 49 – GVA/employee by economic sector, EU25

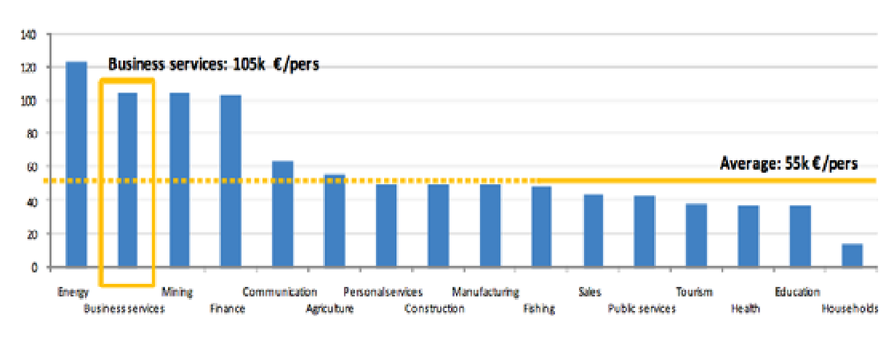
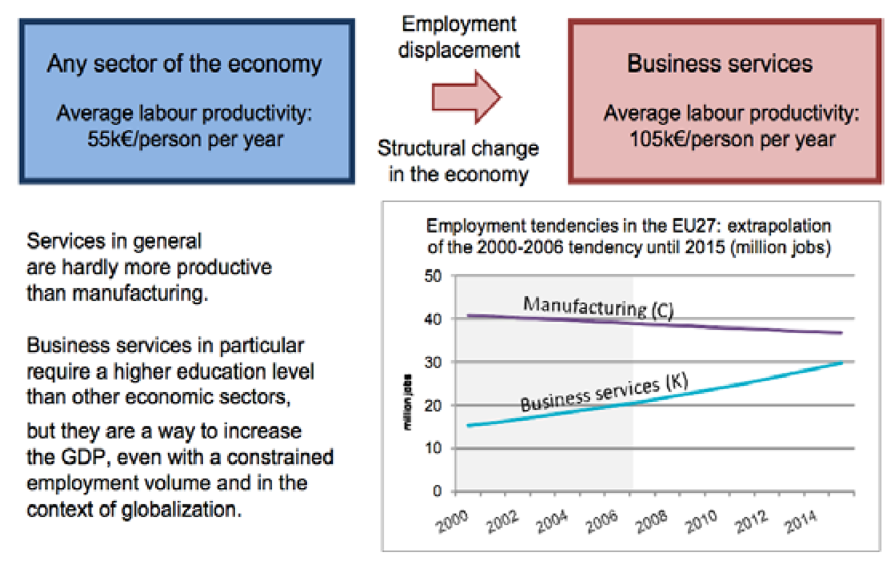


Figure 50 – Outsourcing: a structural displacement from a low-productivity to a high-productivity economic sector



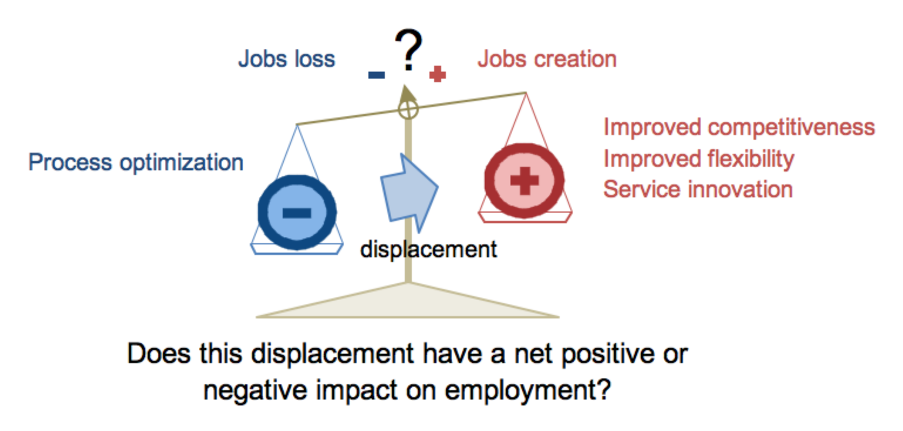
Source Figure 49: Eurostat (national accounts)

Labour productivity in the business services sector measured at a macro-economic level tends to stagnate. Even with that, a transfer of 500,000 jobs from any sector of the economy to the business services sector within a year would represent a growth of the European GDP of € 25 bn per year: 500,000 x (105 – 55) = € 25,000,000 k/year (€ 25 bn/year)

Efficiency improvement is achieved through modernization of the processes and semi-automation, not through the operation of outsourcing or transfer of a worker from one economic sector to the other. Though no statistics are available on this issue, business-process-services providers generally consider that, after optimization of the processes, it is possible to achieve the same results as an in-house department with only 60% of the initial personnel. This value is coherent with the labour productivity jump from the rest of the economy to the business services sector.

Consequently, outsourcing, even in a near-shoring form, has a direct negative effect on employment levels. On the other hand, it increases the competitiveness of the client firms and, by providing more flexibility to innovative firms, it fosters activity in the most dynamic sectors of the economy. Last but not least, business services are themselves innovative by constantly providing new high-value-added services to their clients.

Figure 51 – Outsourcing and employment: a social problem



The essential question is: is the indirect positive effect on employment sufficient to compensate for the direct negative effect and achieve a positive net employment creation? This issue is dealt with in more detail in Section 5.

How fast is the displacement occurring?

No statistical data is available to measure the pace of the outsourcing movement from other economic sectors to the services sector. Employment fluctuations are not a sufficient indicator: they have causes other than the broadband-related transfer of jobs.

In the current literature, BPO is closely related to the provision of IT services. The market leaders in BPO are former IT companies that have diversified their offerings of services. Major market research companies include the BPO and managed services market in the IT market. In accordance with this, we may assume that BPO is closely linked to the provision of services by IT service providers. With this hypothesis, it makes sense to consider in the model that the pattern of BPO adoption is similar to the adoption of e-business.

By similarity with the figures found in Section 4.4, we consider that BPO increases by 3% per year in Europe. The displacement of 3% of the business services jobs from all sectors of the economy hit by this phenomenon represents a displacement of 725,000 jobs per year at the European level, in the reference year 2006. Considering that only 60% of these jobs are transferred to service providers, there is an increase of 435,000 jobs in the business services sector. The overall impact on labour productivity is 0.15%, with a loss of 290,000 jobs at the European level.

BPO has important social consequences, although its impact on productivity can be considered very limited. However, a hasty conclusion on the negative impact of broadband and outsourcing on employment in Europe is premature at this point of the discussion.

4.5.3 What about off-shoring?

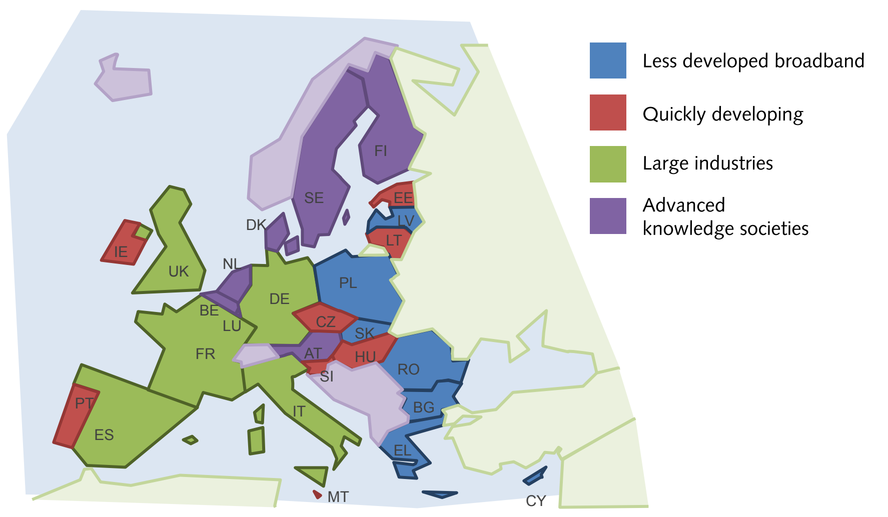
"Outsourcing", the transfer of an economic activity to another company, can be associated with "off-shoring", the transfer of activity to another country or region of the world.

The "second wave" of off-shoring concerns white-collar workers

Calculation is based on input-output statistics

A first wave of off-shoring has occurred in the manufacturing sector, with the transfer of many production facilities to so-called "low-cost" countries. During this first wave of off-shoring, "white-collar" workers (the most qualified and creative class of workers) felt relatively protected against this phenomenon by their higher level of education. Today, not only low-skills jobs but also highly skilled jobs in the services sector are displaced to Eastern Europe, India or China. The displacement of service jobs now hits another category of workers and undermines the developed countries' confidence in their comparative advantage in high-value-added activities. This phenomenon is described in "The new wave of outsourcing" by Bardhan and Kroll (2003) [6].

Figure 52 – The four country groups



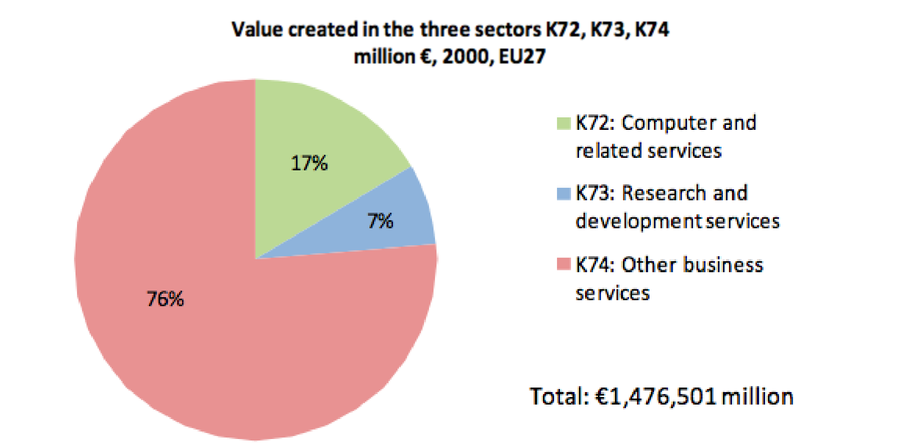
There are very few reliable statistics on off-shoring available: this information gap greatly limits any analysis of the problem. Essential analytical tools are the input–output tables which have been collected by the OECD and Eurostat over the last few years. These tables provide an evaluation of the transfers of value from one sector of the economy to another, including import and export flows.

The groups of countries that we defined at the beginning of this study (see Figure 52) are suitable for analyzing the trading of business services within Europe: they correspond to the most important European source and target off-shoring regions.

Source Figure 53: Eurostat (Input/Output tables)

The following data concerning knowledge-intensive business services (KIBS) was compiled for 2000, in the three NACE categories 72 (Computer and related services), 73 (Research and development services) and 74 (other business services). More recent data is too incomplete or inconsistent and cannot be efficiently compiled. Sector 74 is the largest NACE sector considered, accounting for 76% of the economic value of the three sectors (see Figure 53).

Figure 53 – Comparison of the three sectors K72, K73 and K74



One can observe that companies from the large industrial countries buy IT services from the quickly developing countries and successfully export research services and other business services to Europe and the rest of the world:

Result: large countries benefit most from off-shoring

- Trade in business services between Europe and other parts of the world only represents about 5% of the European market for business services. Large industrial countries (UK, Germany, France, Italy, Spain) are the only net exporters. Europe is a net importer of business services.
- When looking at only the IT sector (Table 19), the quickly developing countries appear to export services massively (50% of the production) to the EU and to the rest of the world. The EU is a global exporter of IT services. Still, there is a very important deficit in Sector 74 in these countries. A large part of this deficit is satisfied on the intra-European market: actually, quickly developing countries import a lot of business services from the large industrial countries (Table 18).
- When looking at all three sectors together, large countries benefit most from BPO. This success is due, in particular, to exports in Sector 74 (other business services such as legal services, accounting, engineering, etc).

Table 18 – Intra-EU and worldwide trade of business services

Year 2000 million €	72+73+74 (100%)			
	Net export IntraEU	Net export World	Import/ Total use	Export/ Total supply
CG1 – Less developed knowledge societies	-541	-1,297	11%	8%
CG2 – Quickly developing	-8,224	-14,279	35%	17%
CG3 – Large industries	1,922	5,747	7%	8%
CG4 – Advanced knowledge societies	-1,336	-3,636	15%	14%
EU		-5,320	5%	4%

Table 19 – Intra-EU and worldwide trade of computer and related services

Year 2000 million €	72 Computer and related services (17%)			
	Net export IntraEU	Net export World	Import/ Total use	Export/ Total supply
CG1 – Less developed knowledge societies	-289	-787	28%	11%
CG2 – Quickly developing	2,842	4,560	9%	50%
CG3 – Large industries	-1,226	-595	7%	7%
CG4 – Advanced knowledge societies	573	846	12%	13%
EU		2,125	4%	4%

Table 20 – Intra-EU and worldwide trade of research and development services

Year 2000 million €	73 Research and development (7%)			
	Net export IntraEU	Net export World	Import/ Total use	Export/ Total supply
CG1 – Less developed knowledge societies	-4	-1	11%	11%
CG2 – Quickly developing	-1,238	-2,510	61%	7%
CG3 – Large industries	656	1,672	9%	11%
CG4 – Advanced knowledge societies	-20	-82	25%	25%
EU		-307	7%	6%

Table 21 – Intra-EU and worldwide trade of other business services

Year 2000 million €	74 Other business services (76%)			
	Net export IntraEU	Net export World	Import/ Total use	Export/ Total supply
CG1 – Less developed knowledge societies	-248	-510	9%	8%
CG2 – Quickly developing	-9,828	-16,328	38%	11%
CG3 – Large industries	2,493	4,669	7%	7%
CG4 – Advanced knowledge societies	-1,889	-4,399	15%	13%
EU		-7,139	5%	4%

The four country groups act more as partners than as competitors in making Europe the most developed economy in the world. Their competencies complement each other:

- low-cost workforce and high economic growth in the less developed countries
- competitive engineering skills and quickly improving education systems in the quickly developing countries
- large markets, strong financial systems and successful multinational companies in the western European countries
- high-tech and innovative activities and a very high education level in the most advanced knowledge societies.

Eastern Europe has to prepare for change

Even so, central and eastern European countries are much less populated than other developing regions of the world. The less-developed country group defined in this study accounts for fewer than 90 million inhabitants, compared to more than 2.4 billion inhabitants in China and India. Because of this demographic limitation, Eastern Europe will not be able to play for long the role of a “low-cost workforce tank”, unlike the huge rural populations of Asia. Consequently, the average salary levels are to be expected to increase more quickly in Eastern Europe than in Asia. By focusing on modernization and education, Eastern Europe has to prepare for such a change in its economy in the medium-term.

5 The impact of broadband on growth

Productivity improvement through process optimization or “rationalization” in companies is often associated with people losing their job. This kind of association defends the view that productivity and employment are complementary: raising productivity automatically makes employment sink and the converse is also the case. Recent economic analyses defend such a point of view: see “The Role of Labour-Market Changes In the Slowdown of European Productivity Growth“ from Dew-Becker and Gordon (2007) [20].

The trade-off between employment and productivity is true when overall production remains constant, according to the equation below:

Value added = employment x labour productivity

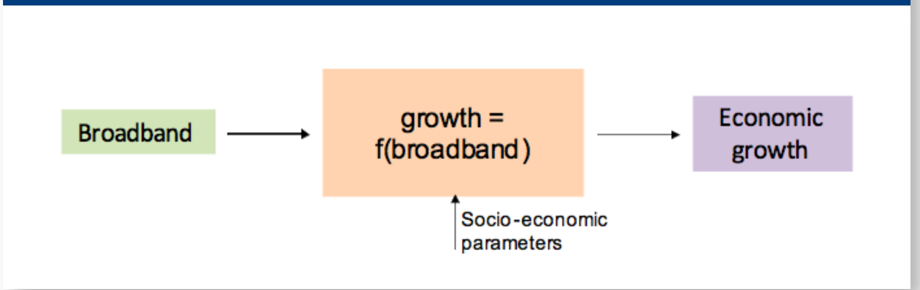
The analysis of the economic impact of broadband shows that broadband contributes concretely to growth, thus allowing escape from the employment–productivity trade-off and improving both terms of the equation.

Broadband contributes concretely to growth

5.1 Overview of the methodological approach

Analyses of the impact of broadband on growth that have been made so far tend to establish a statistical correlation between broadband development and economic growth (see Figure 54).

Figure 54 – A simple "growth = f(broadband)" function



This approach does not consider the way broadband concretely impacts an economy, but rather establishes a statistical link between broadband connectivity and economic prosperity. Since economic growth is also impacted by many other factors not related to broadband, the analysis of very large datasets at a very detailed level is required, in order to get usable results (see the analysis from Gillett and Lehr [62]).

In an OECD workshop that took place in London in May 2007, the limits of this kind of approach and the need to base an economic analysis of broadband on a more detailed understanding of the way it impacts the economic activity were formulated.

A more detailed economic model is needed

The approach used in this study is based on the preceding analysis of the impact of broadband on the companies' productivity (see Section 4). This analysis:

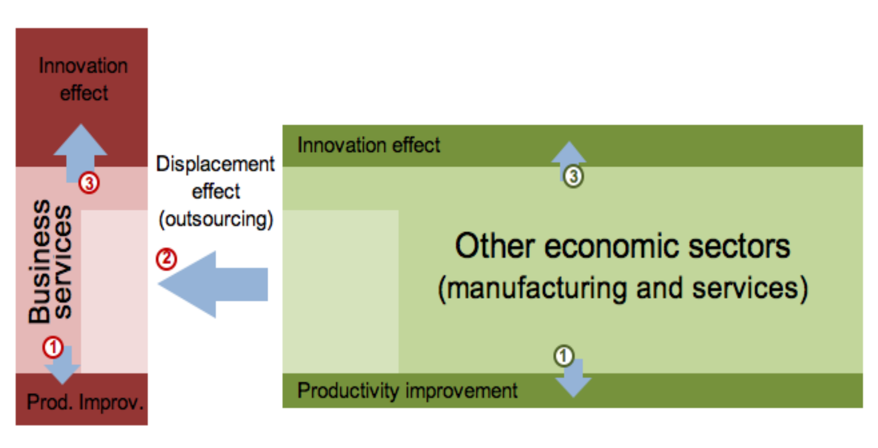
- goes further than considering broadband penetration in companies at the connectivity level, by using statistics on the integration of broadband-based technologies into the companies' processes
- differentiates between economic sectors (manufacturing, business services and other services)
- is based on the calculation of the impact of broadband-related changes in business processes at the company level.

This third point introduces a new dimension in the analysis of the economic impact of broadband, for a better understanding of the concrete effects of broadband in an economy. The analysis of the impact of broadband on the companies' productivity establishes:

Analysis at the company level introduces a new dimension in the model

- a productivity improvement due to the adoption of e-business technologies, depending on the economic sector considered
- a displacement of activity from other economic sectors to the business services sector (business services outsourcing).

Figure 55 – Combination of the three broadband-related impacts on growth



The analysis of the impact of broadband on growth introduces a third effect: "real" growth due to broadband-related innovation. This effect also depends on the economic sector considered.

The impact of these three broadband-related effects is quantified for each of the economic sectors under consideration on the basis of the employment statistics and in terms of value-added growth.

5.2 The impact of productivity on growth of employment and value added

At the micro-economic level, one can observe that the effects of a process improvement are spread over time:

- A company improves its processes to increase its employees' efficiency. After the change has been made, the company is able to produce more with the same personnel or produce the same with fewer personal.
- The company takes advantage of its improved production processes to improve its position in the market. This takes time: in the short term, inputs are too large for the demand. In the most likely case, employment is more flexible than the output market and employment reductions occur.
- After a certain time, the benefits of the process improvement become reality: sales increase and more input is needed to face the demand. The previous level of employment may be reached or even overtaken. The long-term employment level after a process improvement cannot be determined in advance.

We can draw the following conclusions at the micro-economic level (see Figure 56):

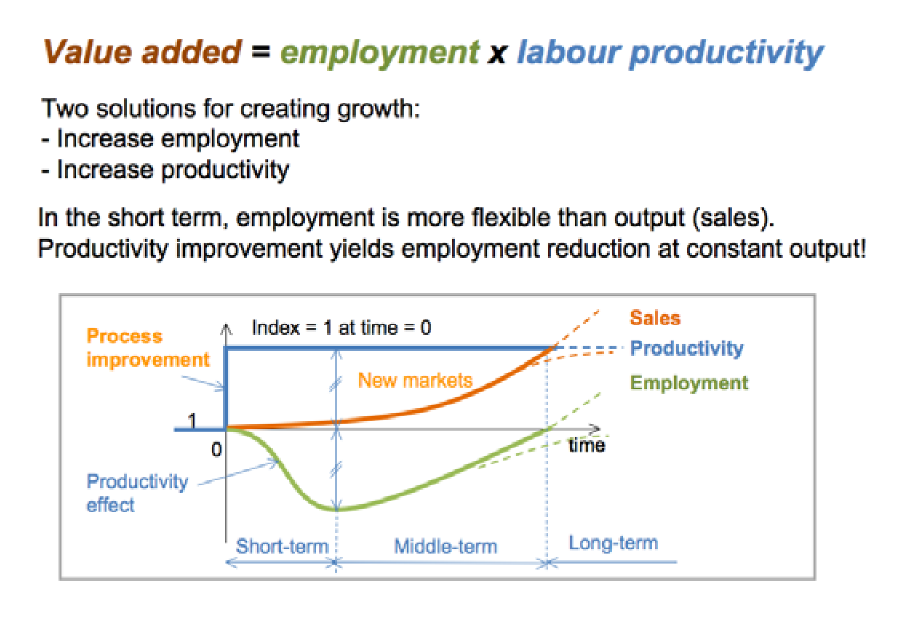
- In the short term, productivity improvement has a negative effect on employment and no effect on growth.
- In the long term, the effect of productivity improvement on employment is undefined. The effect on growth is positive, due to a better position on the market.

In order to model the effect of productivity improvement at a macro-economic level, we distinguish the short-term and long-term effects:

- The impact of productivity improvement on employment is counted negatively.

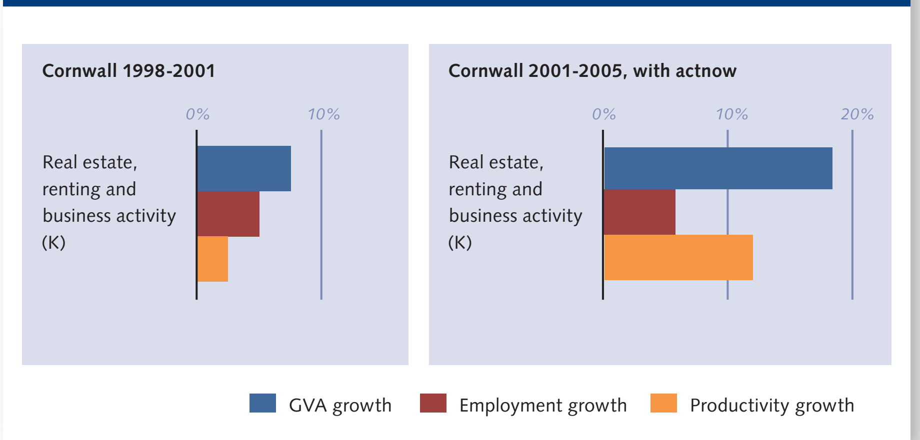
- On the short term, productivity improvement has no impact on sales volumes: productivity improvement has no direct impact on the gross value added (GVA).
- At the European level, employment statistics reveal the long-term impact of a better position in the market.

Figure 56 – Productivity improvement and timely evolution of employment and value-added



The calculation framework is verified by the case of actnow in Cornwall: actnow has contributed to the development of the use of broadband in companies in the business services sector. According to the regional statistics in Cornwall in this sector over the period of the project, broadband development did not have an impact on employment growth, but has had a very important impact on productivity and, thus, value-added growth and wages level (see Figure 57).

Figure 57 – The business services sector in Cornwall, 1998–2005



The companies that were interviewed in the region for the case study confirmed that, after a period of growth at a constant employment level, the increased competitiveness of the company allowed it to continue the development and hire new staff.

5.3 Analysis of employment growth in the business services sector

The business services sector is one of the most dynamic in the European economy:

- NACE sector K represents 22.0% of the Gross Value Added (GVA) in 2005 in the EU27, and 26.4% of the GVA growth between 2000 and 2006 (Source: Eurostat, National Accounts)
- Sector K accounts for 9.3% of the employment in 2006 in the EU27 and 38.8% of the employment growth between 2000 and 2006. (Source: Eurostat, Labour Force Survey)

- Over this period, the KIBS sector has created on average 772,000 jobs per year (Source: our calculations are based on Eurostat, Labour Force Survey and Structural Business Statistics).

The impact of non-internet ICT in the KIBS sector is coming to saturation, as desktop computers and office software are now commonplace (97% of the companies in the NACE sector K in the EU27 use computers. Source: "Community survey on ICT use in companies").

Dynamism in the KIBS sector exploits the new opportunities of broadband

Activities in the KIBS sector require a very intensive exchange of information between the service providers and their customers. Dynamism in the KIBS sector exploits the new opportunities of broadband internet to increase interconnection between the service provider's information system and that of its client, thus greatly increasing the possibilities of the service relationship. For most KIBS firms, for example, engineering offices or accountants, broadband internet and online services are not the core of their activity. Still, these firms indirectly depend on broadband internet to provide competitive services to their customers. No growing company in the KIBS sector can give up broadband internet.

5.3.1 Modelling growth

Due to the high dependency of knowledge-intensive business services on broadband, 100% of the growth in this sector can be directly or indirectly related to the development of broadband. Several broadband-related effects, though, can be differentiated:

- Many of the jobs created in the KIBS sector are due to outsourcing: they correspond to a displacement of activity from other sectors of the economy. It has been calculated previously in this study that 435,000 jobs were displaced to the business services sector in the base year of calculation (2006). Thus, 435,000 jobs out of the 772,000 increase in jobs in the KIBS sector are in fact displaced jobs, not created jobs (see Figure 58).
- As previously explained, productivity improvement is accounted negatively in the employment calculation. The 0.58% annual increase of labour productivity due to the use of e-business technologies in the business services sector yields a loss of 103,000 jobs per year in Europe.
- After accounting for the effects of productivity improvement and outsourcing, there is still a net creation of 440,000 jobs in the KIBS sector in a base year.

Innovation is key to real growth

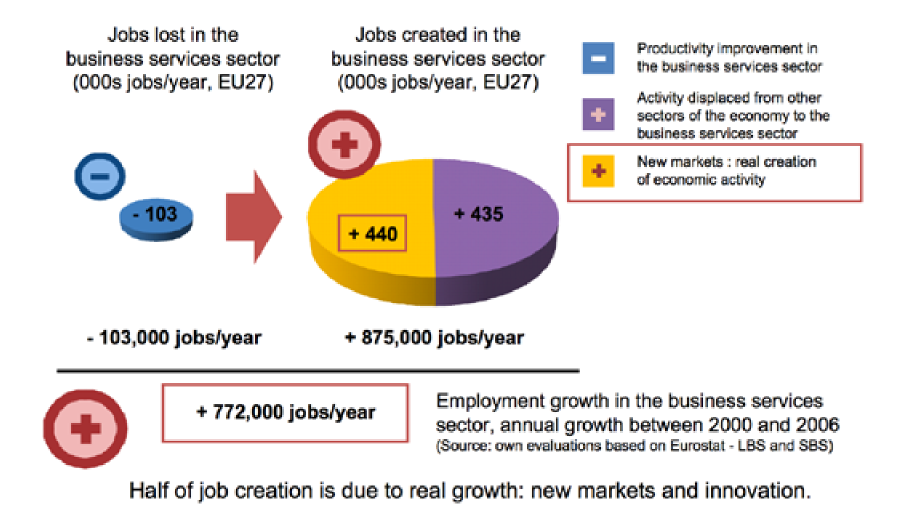
The net creation of jobs corresponds to a real increase in the economic activity. This increase may have two causes:

- Quantitative: an increase of the European and worldwide business services markets and an increase in market share by the European providers
- Qualitative: development of new markets by the creation of innovative business services

Of the two factors identified above, innovation is the most important factor for activity growth in the services sector. Indeed, providing innovative services is the most successful way for service providers to increase their share in already established markets. Innovation provokes displacement effects from one service provider to another and has a strong impact on market share. This is also the case in developing national markets such as those in the eastern European countries.

The functionalities to be provided by web platforms are virtually infinite; there is plenty of room for innovation and profitable ventures involving several service providers. Regions of the world which are in advance in the development of such services export their technology and business models to other regions of the world.

Figure 58 – Employment displacement and creation in the business services sector, base year (2006)



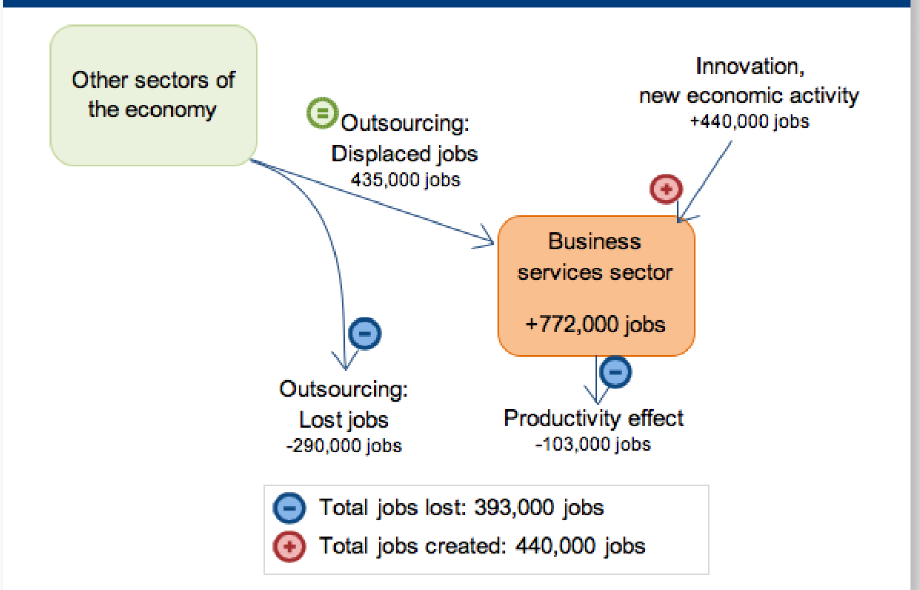
5.3.2 A broader perspective: jobs created and lost due to process optimization

The calculation in Figure 58 focuses on jobs created and jobs lost in the business services sector. It does not consider jobs lost in other economic sectors through outsourcing to the business services sector. These jobs need to be taken into account when comparing jobs created and jobs lost due to process optimization.

The analysis has so far assessed that the use of broadband technologies in the business services sector has two negative effects on employment:

- Productivity improvements in the business services sector yield a loss of 103,000 jobs in the base year (2006).
- Outsourcing some activity from traditional sectors of the economy to the business services sector creates 435,000 new jobs in this sector, but 290,000 jobs are lost in the base year when considering the whole economy (see Section 4.5.2). This loss of jobs is also due to process optimization and productivity improvement in the business services sector.

Figure 59 – Jobs created and lost: balance in the business services sector



More jobs are created than lost

Considering these two effects (see Figure 59), 393,000 jobs are lost in the base year due to broadband-related productivity improvement in the business services sector. On the other hand, over the same period of time, 440,000 jobs are created in new economic activities.

Due to the creation of new activity and innovation, the employment balance is positive: the ratio of jobs created to jobs lost is equal to 112%. A ratio of at least 100% is necessary to achieve net job creation.

5.4 Employment in other economic sectors

5.4.1 Methodology

The analysis in Section 4 assessed that broadband has a positive impact on productivity in all economic sectors. More precisely, we assessed that broadband has an impact on information-intensive functions of a company involving contact with outside bodies. Such activities typically represent 25% of a company's activity in the manufacturing sector, 50% in the services sector (without business services) and 100% in the business services sector (see Section 4.4.2).

The dynamism of the business services sector shows that broadband-related innovation is essential, along with productivity effects, in the analysis of the impact of broadband on growth. The creation of innovative business services is tightly related to the use of broadband to improve processes, information flows and employee efficiency.

The activity of in-house business services and of companies in the KIBS sector are of the same nature

The activity of in-house business services and of companies in the KIBS sector are of the same nature. In both cases, the use of broadband technology allows productivity improvements and personnel reductions, but also the development of new services and new support functions in a company. Innovation effects also take place in other economic sectors and have to be taken into account.

In the KIBS sector, we could assume that 100% of the innovative activity is directly or indirectly related to broadband. This is not the case in the rest of the economy, where information-intensive activities are diffused in other kinds of activities. The impact of broadband-related innovation in the rest of the economy cannot be calculated directly, unlike in the business services sector.

The broadband-related innovative effects in the rest of the economy are evaluated by similarity with the business services sector:

- Ratio of jobs created to jobs lost: In the business services sector, a relationship was found between employment reduction through process optimization and job creation through service innovation, with a ratio of 112%. In the model, the same relation between jobs created and jobs lost is assumed for in-house business services in other economic sectors.
- Jobs lost: As found in the analysis of the impact of broadband on productivity, the progression of the use of online services in the manufacturing and services sector yields

a macro-economic productivity improvement of 0.14% in the manufacturing sector and 0.32% in the services sector (see Table 17). At a constant output level, this productivity improvement yields a loss of 491,000 jobs in the economy in the base year (see Figure 60). This figure corresponds to employment reductions due to process optimization in in-house business services.

- Jobs created: According to the relationship between created jobs and lost jobs, the loss of 491,000 jobs due to process optimization would then be compensated by the creation of 549,000 jobs in the base year through service innovation in the economy, not including the business services sector.

5.4.2 Results of the analysis

The aggregated results from the business services sector and the rest of the economy highlights the displacement of more than 1.3 million jobs from traditional sectors of the economy to the business services sector or to new activities in the same economic sector. In the model, this displacement is due to three effects:

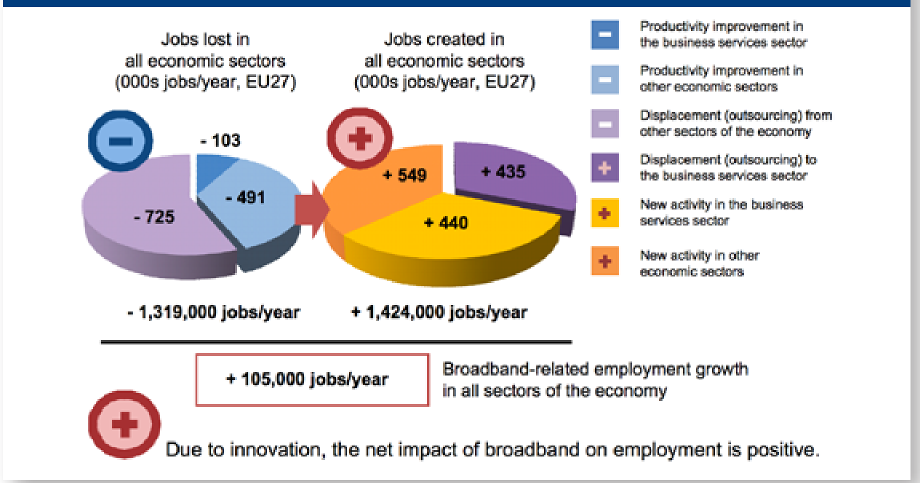
- employment reduction due to broadband-related productivity improvement (see Section 4.4)
- outsourcing from traditional sectors of the economy to the business services sector, fundamentally made possible by the development of broadband (as described in Section 4.5)
- innovation in business services both in the KIBS sector and in-house business services. As described in Section 5.3, this innovation cannot be considered separately from broadband development.

THE NET JOBS CREATION HAS ITS ROOTS IN A BROADER STRUCTURAL PHENOMENON

The resulting net employment creation of 105,000 jobs per year has its roots in a structural phenomenon that affects the jobs of more than 1 million people each year.

The employees losing their jobs in the process of broadband-related productivity improvement are highly-educated, experienced office workers. Although their IT skills are not up to date in all cases, their competencies are key to the development of the most dynamic and innovative sectors of the economy. Lifelong learning should ease the integration of these workers into new activities.

Figure 60 – Employment growth, all sectors, base year (2006)



The results from the model show that net job creation is positive. This positive result is largely due to innovation. In order to be successful in Europe, the development of broadband has to be closely associated with innovation policies providing the best conditions for the creation of new services. Innovative services improve the competitiveness of all companies in the European economy, including in the manufacturing sector. Understanding and fostering innovation in the services sector is necessary to guarantee that broadband-related changes in employment are positive.

5.5 Impact on GDP

The impact of outsourcing and the creation of innovative activities have been evaluated previously in terms of employment. These results can be expressed in terms of value added, by multiplying employment growth with labour productivity in the economic sectors under consideration.

As previously explained, in the model, productivity improvements allow companies to achieve the same level of production with fewer personnel. Consistent with this assumption, the impact of broadband on productivity does not yield additional added value in the model.

The long-term effects of productivity improvement (namely, a better position in the markets and an increase in sales) are accounted as “new activities”:

- 440,000 jobs are created in new activities in the business services sector. Considering a labour productivity of € 105 k per employee in this sector, it is equivalent to an increase in the economic activity of € 46.2 bn in the base year.
- 549,000 jobs are created in new activities in the rest of the economy. Considering an average labour productivity of € 55 k per employee, € 30.2 bn per year added value is produced in these new activities.

The impact of the displacement of activity from traditional economic sectors to the business services sector is quantified as follows (see Figure 61):

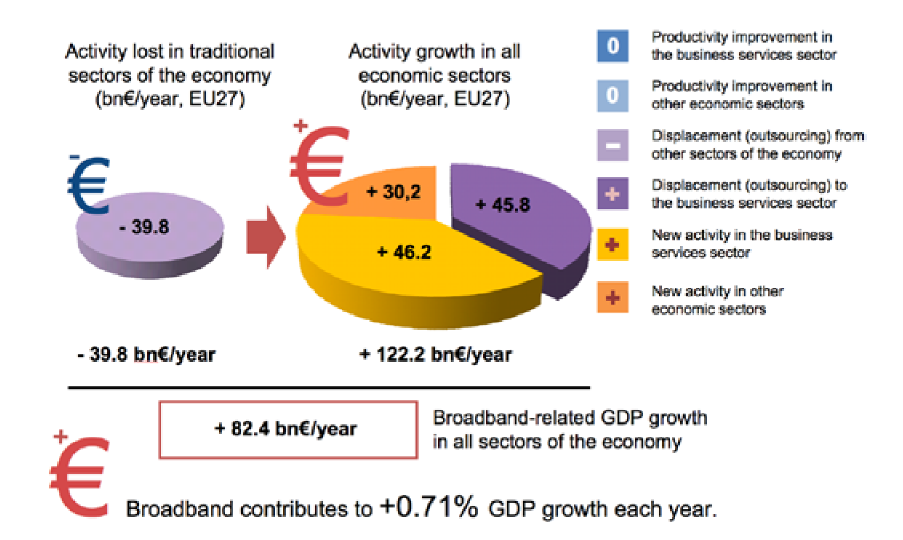
- On the one hand, reduction of employment in traditional sectors of the economy is equivalent to a reduction of € 39.8 bn economic activity in these sectors.
- On the other hand, employment creation in the business services sector yields an increase of € 45.8 bn economic activity.
- The net creation of value due to outsourcing is equal to € 6.0 bn per year. As expected, outsourcing is mostly a displacement effect: its direct impact on the GVA is very limited. The most important effect of outsourcing from a macro-economic point of view is a better allocation of competencies in order to develop innovative activities.

The impact of broadband on growth is due to a better allocation of competencies

The total contribution of broadband-related effects to GDP growth in Europe, including outsourcing and innovative activities, is equal to € 82.4 bn per year. Considering a European GDP of € 11,583 bn in 2006, the broadband-related activities contribute 0.71% of the growth of the European GDP in the base year.

Broadband-related GDP growth is sustainable and cumulative from year to year: after € 82.4 bn additional gross domestic product in the first year, a continuous movement toward new markets will allow an additional growth of about € 165 bn in the second year as compared to the initial reference year, etc. Growth of innovative markets can be a rolling phenomenon, as long as investments in the broadband infrastructure are sustained.

Figure 61 – GDP growth, all sectors, base year (2006)



In the stagnating European demographic context, competencies are a limiting factor on economic development. The value created in new markets is the result of better allocation of people and competencies:

- Due to efficiency improvements, competent people in traditional sectors of the economy are no longer required, while the produced value remains constant.
- These people invest their competencies in the development of new markets and innovation. If the conditions are favourable, net employment creation is positive.

5.6 GDP growth and country groups

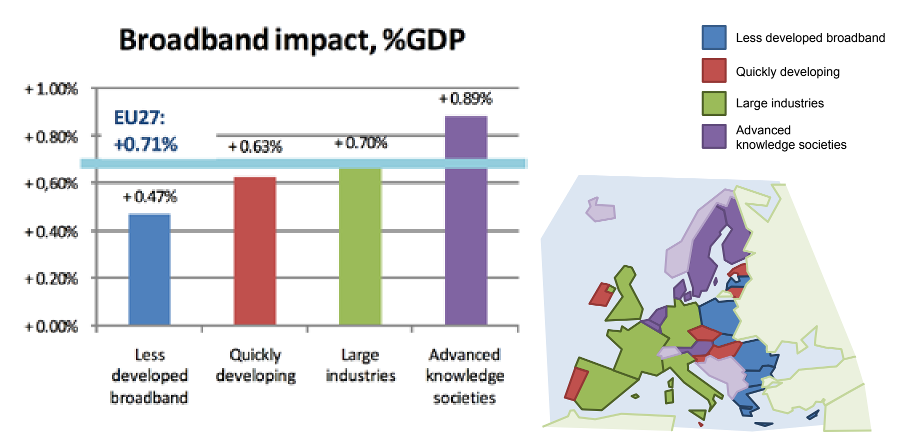
There are important disparities in broadband use between the European member states. On the basis of about 30 indicators, we defined four groups of countries (see Section 2.2.1):

- Less-developed knowledge societies are countries with a historical handicap in the development of telecommunications infrastructures, still at the beginning of their implementation of policies oriented to the knowledge society.
- Quickly developing countries are historically lagging in the development of telecommunications infrastructures, now successfully catching up with advanced countries in the use of broadband.
- Large industries are large economic powers, confronted with the problem of generalizing changes quickly enough and at a large scale.
- Advanced knowledge societies are countries leading and experimenting the development of a successful knowledge society.

The most advanced countries get the most benefit from broadband

The most advanced countries will get the most benefit from broadband, as they quickly move toward highly innovative markets while improving labour productivity. The annual broadband-related growth in these countries is evaluated as 0.89% of the GDP and will continue to increase.

Figure 62 – GDP growth when there are undifferentiated policies at the European level, base year (2006)



By comparison, countries with less-developed economies take less advantage of broadband: annual broadband-related growth is evaluated as 0.47% of the GDP. This advantage, though, is growing along with broadband development. The example of the quickly developing knowledge societies shows that countries with less-developed economies benefit from focusing on broadband development.

5.7 Conclusion

Broadband internet fosters innovation and the development of service markets, thus creating new fields of activity for European educated workers. The development of these new services occurs through the transfer of workers and competencies from traditional sectors of the economy to the most dynamic sectors. As the model shows, broadband has a positive impact on productivity, growth and employment levels.

According to the model, 1.3 bn jobs are lost each year in Europe in traditional sectors of the economy, while 1.4 bn jobs are created in dynamic sectors. The development of new markets creates more than 100,000 jobs per year and increases the European GDP by € 82.4 bn per year (0.71%).

6 Broadband development scenarios

The following analysis presents the expected broadband development and economic impact in Europe between 2006 and 2015.

6.1 Broadband coverage and penetration: development of the infrastructure

The following forecasts are based on a model used to simulate the development of the broadband infrastructure until 2015 in the 27 EU member states. This model was specifically developed for this study by WIK, a German research and consulting institute specializing in telecommunications infrastructure markets.

Scenarios are based on the development plans of the internet service providers

The construction of the model is primarily based on the available, published information about the development plans of incumbent telecommunications service providers and their facilities-based competitors in 15 member states. The analysis of press releases, annual reports and the available literature on the development of next-generation networks has been completed, in more than 10 member states, with interviews of experts in the broadband telecommunications sector. Less comprehensive information on the telecommunications markets in the remaining 12 member states has also been collected. The results obtained at the country level were aggregated for each country group and the EU27. More information about this model is given in Annex 7.

6.1.1 Broadband coverage

ADSL and cable modem are expected to remain the main broadband technologies in Europe: ADSL coverage should reach 95% of the population in 2015 (see Figure 63). According to their development plans, the European internet services providers do not intend to develop the VDSL and FTTH/B infrastructure on a wide scale in the short term; a much more dynamic investment pattern regarding infrastructure deployment will start after 2010.

Differences in broadband coverage are likely to occur between member states. In particular, fixed wireless access (FWA) is expected to play an important role in countries where the telephone infrastructure is under-developed, while it will remain marginal in other countries. VDSL and FTTH/B development will occur earlier in most advanced knowledge societies (see Figure 64).

Figure 63 – Broadband coverage in the EU27 until 2015

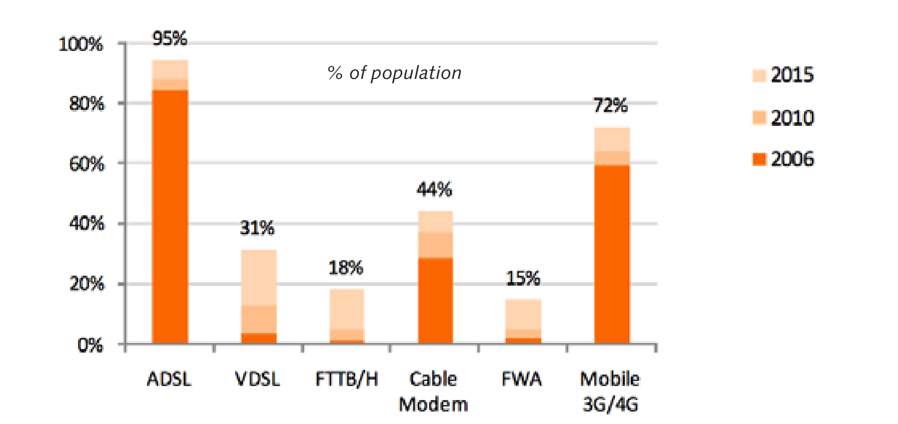
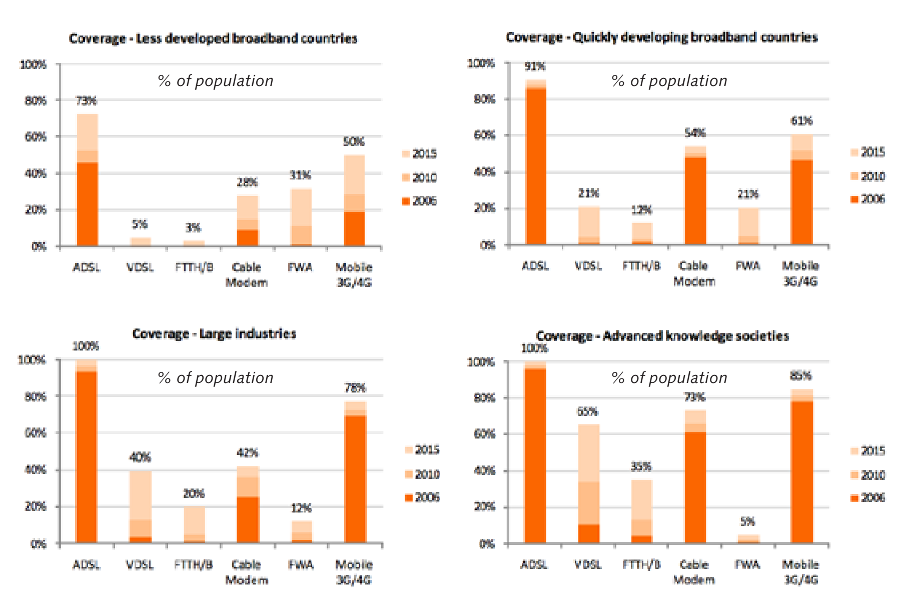


Figure 64 – Coverage – detail per country group



Source Figure 63: Our calculations are based on IDATE [71]

6.1.2 Broadband penetration

The deployment of physical broadband infrastructure is a prerequisite for an increase in broadband penetration. The latter also depends on adoption parameters such as income, willingness to pay, etc. In areas already covered with fixed-link broadband, as is the case in most parts of the large European countries, an important increase in penetration can be sustained without any major investment in the existing infrastructure.

"Mobile-only" households will not subscribe to fixed-link broadband

The following scenario takes into account the fact that a certain number of households use mobile broadband technologies only and do not subscribe to a fixed broadband connection. In order to represent the total broadband penetration, the figures below include mobile-only households using broadband over 3G or 4G mobile networks.

The total broadband penetration is expected to grow to 81% of all households in Europe by 2015 (see Figure 65).

Figure 65 – Total broadband penetration in Europe (EU27)

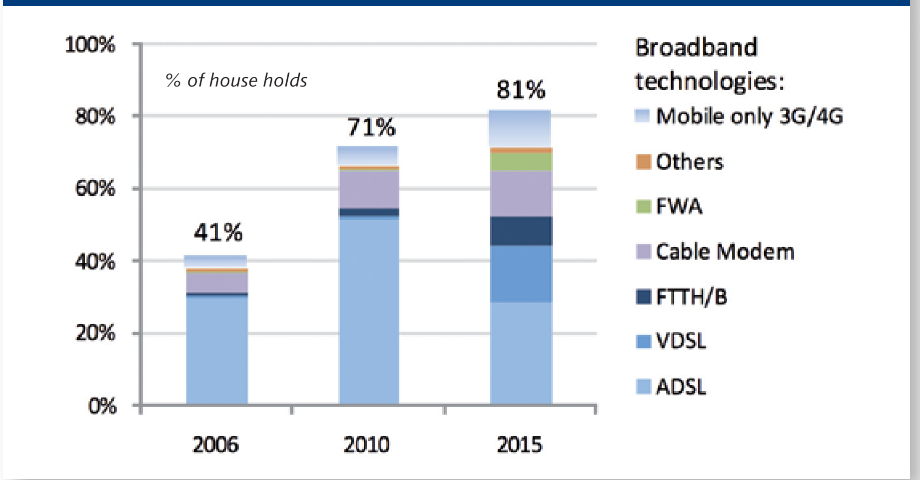
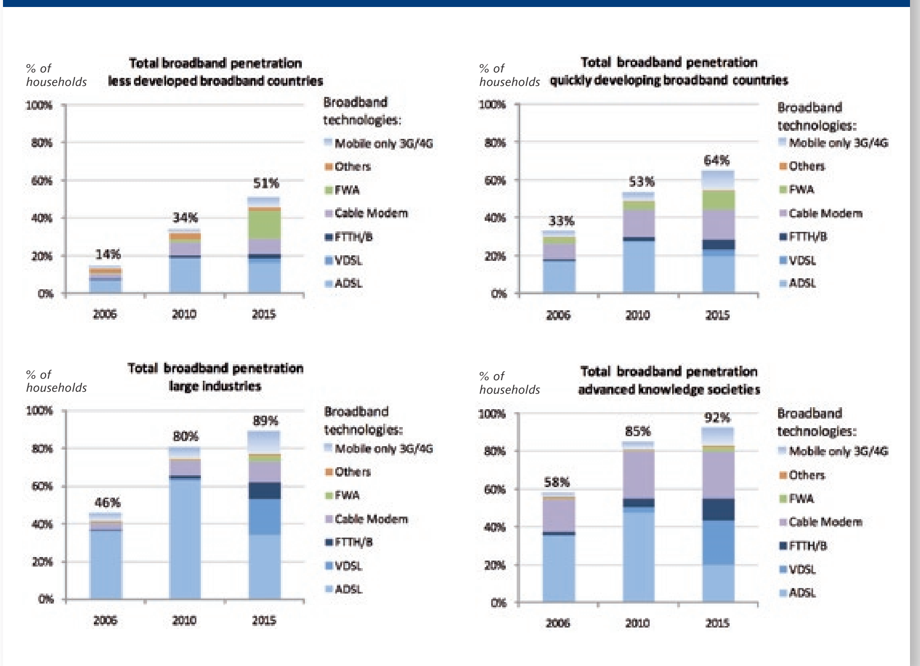


Figure 66 – Broadband penetration until 2015 – detail by country group



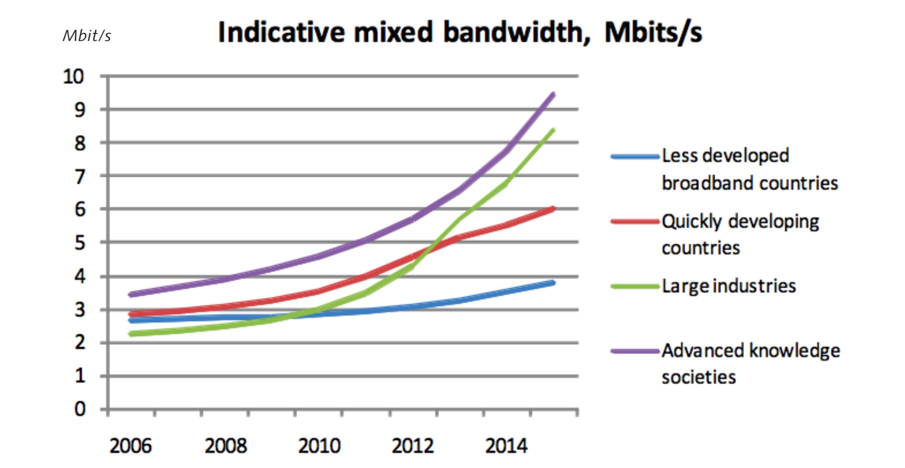
These results can be detailed by country group. Quickly developing countries have concentrated their broadband development in urban areas to date. In most of these countries, many rural areas are not covered by the telephone infrastructure. ADSL is likely not to be easily deployed in these regions. The fast development in urban areas could be followed by a period of slower development, with mobile and fixed wireless access playing an important role (see Figure 66).

A change in the technology mix, with a higher share of fast connections (VDSL and FTTH/B), has an impact on the average bandwidth available to individuals and companies. Early VDSL and FTTH/B development in the most advanced knowledge industries will increase the bandwidth available to users in the next few years. Due to later development of new-generation technologies, this effect will be delayed in the large countries.

Infrastructure development in the two other groups will increase coverage and penetration with a more limited impact on the average bandwidth. FTTH/B development in the main cities, though, will provide companies with the same connection speed as in the other European capital cities.

Figure 67 shows the evolution between 2006 and 2015 of the indicative mixed bandwidth in each group of countries. This indicator was defined at the beginning of this report by attributing an "indicative bandwidth" to each broadband technology. It reveals the impact of the technology mix on the average bandwidth, but does not take into account the technological progress of a technology.

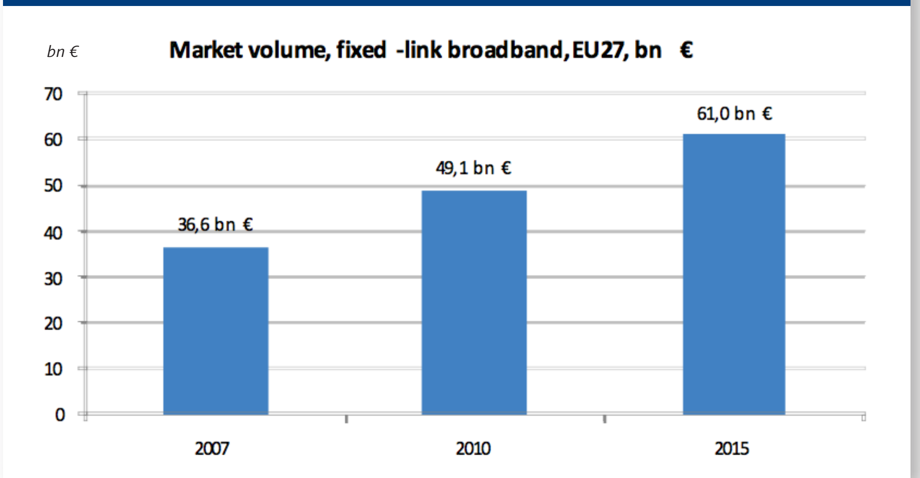
Figure 67 – Indicative mixed bandwidth, 2006–2015



6.1.3 Investment and market volumes

Fixed broadband market volumes should progressively increase over the period 2006–2015, mostly due to a growth in the total number of subscriptions (an increase in penetration). Penetration-driven market growth is a displacement effect from the traditional telephone market. The base scenario takes into account a decrease in subscription prices over time.

Figure 68 – Market volume, fixed-link broadband, base scenario



The evaluation of the investment level for the development of the broadband infrastructure in Europe over the period 2007–2015 is based on the following forecasts:

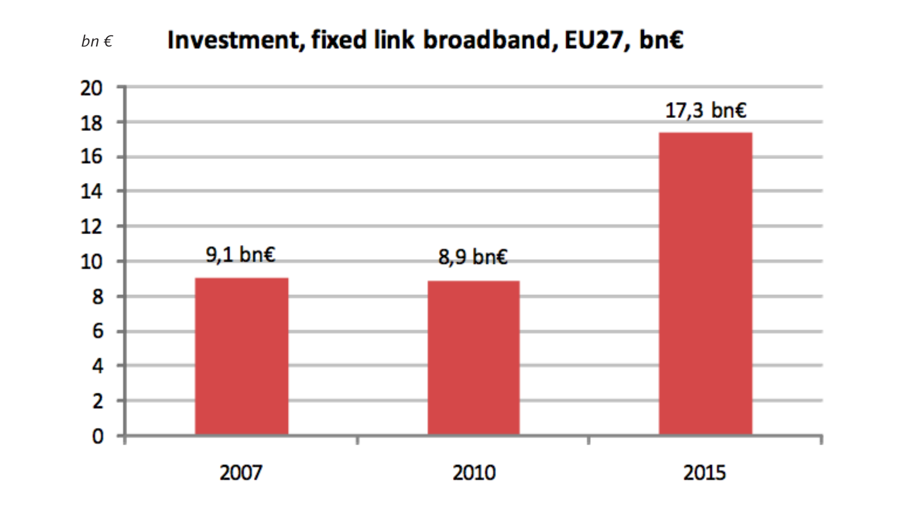
- increase in broadband coverage
- increase in the number of subscriptions
- upgrade of the existing architecture to new technical standards, in order to increase bandwidth without fundamentally changing the technology used (for example: ADSL to ADSL2+ or UMTS to HSPA)
- technology-specific decrease of investment costs over time.

See Annex 7 for more details on the construction of the model underlying these results.

According to the development plans of the main telecommunications service providers in Europe, investment in fixed-link broadband infrastructure will strongly increase over the period 2010–2015 in order to develop the optical-fibre network. In the short term, the reason for a constant investment level despite a growth in the broadband market is twofold:

- The ADSL and cable modem infrastructure has almost reached complete coverage in the largest European countries. Once the infrastructure does not have to be further extended, much less investment is required for each new subscription. Broadband penetration will continue to increase by filling up the available capacity of the existing infrastructure.
- Infrastructure developments are heavy investments which are planned over several years: most development plans over the period 2007–2010 are already foreseeable. Over this period, few European telecommunications services providers have planned a large-scale development of the FTTH/B infrastructure.

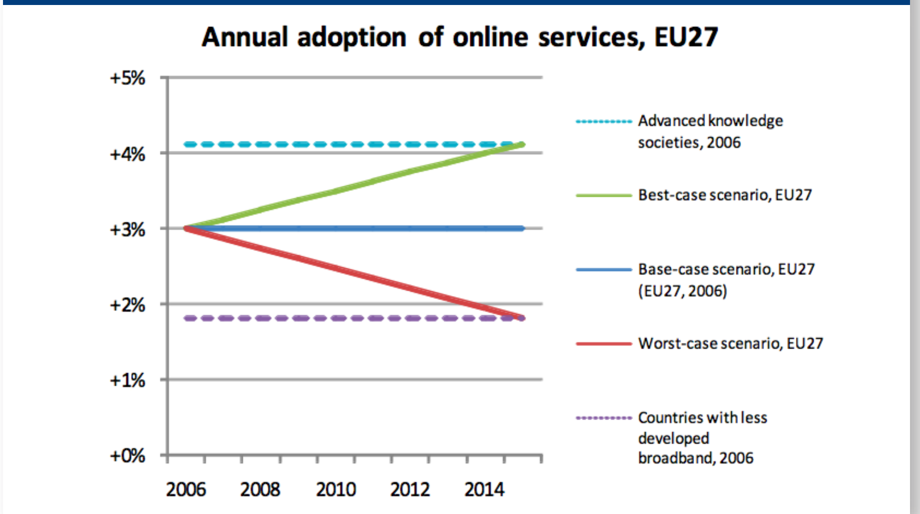
Figure 69 – Investment in fixed-link broadband, base scenario



6.2 The impact of broadband on the economy

6.2.1 Hypothesis about the adoption of broadband services

Figure 70 – Hypotheses on the adoption of online services: best case, base case, worst case



According to the indicator on the use of online services (see Section 2.1.3), the use of online technologies has increased by 3% per year over the period 2004–2006 in the EU27. This adoption rate is crucial to the economic impact of broadband, as it has a direct impact on both productivity improvement and the creation of new activity and innovative services.

In order to illustrate the impact of the adoption of online services, three scenarios were devised for the period 2006–2015 with the following assumptions (see Figure 70):

- Base case: the adoption of online services continues regularly at the same pace of 3% a year, on average in Europe.
- Best case: the adoption of online services across Europe until 2015 speeds up to the current adoption rate in the advanced knowledge societies (4.12%).
- Worst case: the adoption of online services across Europe until 2015 slows down to the current adoption rate in the countries with less developed broadband (1.82%).

Figure 71 – Scenarios: use of online services in the EU27, 2006–2015

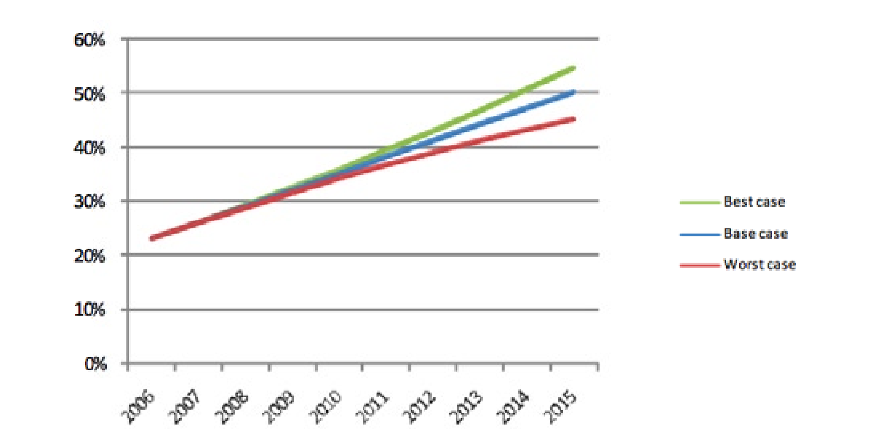
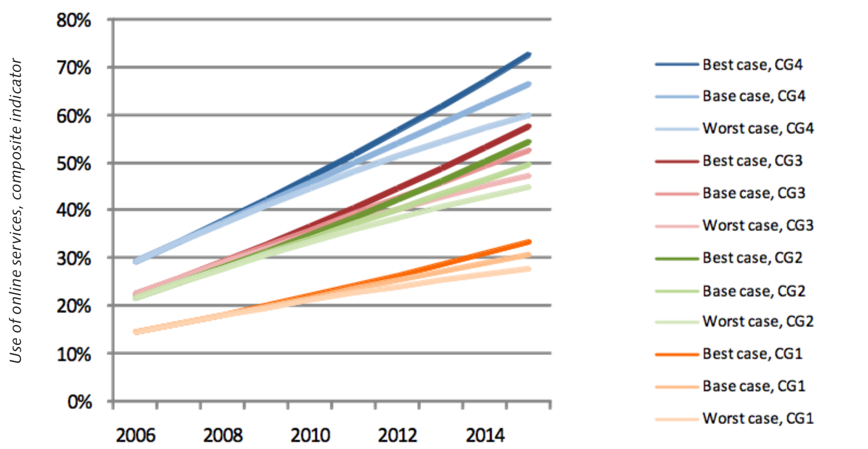


Figure 72 – Use of online services, by country group (three scenarios)



The assumptions above refer to the number of new users of online services each year. Figure 71 illustrates the total number of users, over the period between 2006 and 2015. In the best case, the total use of online services would more than double in the EU27 from 23.06% today to 54.56% in 2015. In the worst case, it would only reach 45.33%.

6.2.2 Seize the chance of innovation: speed matters!

Innovation, or the creation of new activity, is sensible to the “prime” effect. The most advanced users have the best experience of the limits and undeveloped potentials of today’s technologies and organizations. They are the most eager to improve them, push back the limits and overcome challenges. Innovators are advanced users whose problems cannot be solved with today’s solutions.

The first player in a market is likely to get the most benefit from it, become popular and stay a step ahead of his competitors. In an open, global economy, being in the group of innovative countries is necessary to get most of the benefits of innovation and not simply follow the pioneers.

The first player in a market is likely to get the most benefit from it

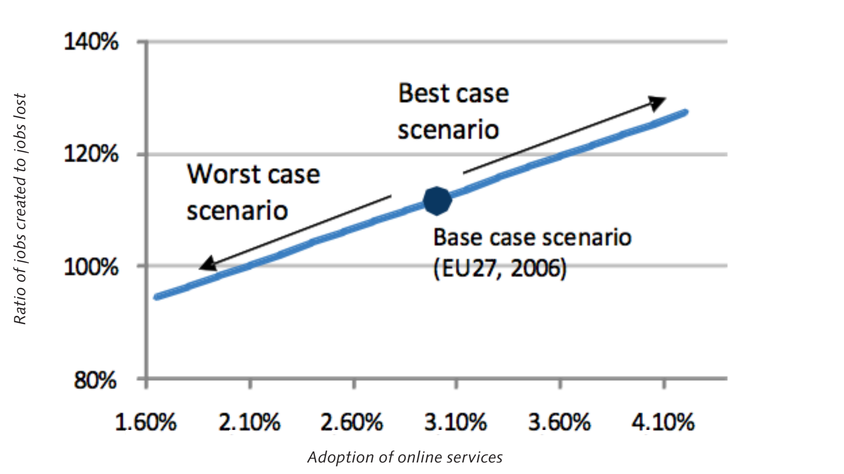
On the other hand, not being at the head of international development would make our markets vulnerable to better products and services coming from other parts of the world and slow down our innovative activity. In a competitive environment, the early bird catches the worm.

More jobs are created in the case of a faster adoption of online technology

In the model, a faster adoption of online technologies increases the benefit of innovation. The ratio of the number of jobs created to the number of jobs lost (see Section 5.3) is higher in the case of a faster adoption of online technology.

It has been previously established that the ratio of jobs created to jobs lost in the base year was equal to 112%, with an adoption rate of online services equal to 3%. In the large developed countries, the adoption rate of online services is as high as 3.3%, with a ratio of jobs created to jobs lost equal to 116%. The relationship between the adoption of online services and the benefits of innovation is considered linear around these two points.

Figure 73 – The evolution of the jobs created through broadband-related innovative activities as a function of the adoption of online services



In the best-case scenario, the adoption rate of online services increases from 3% to 4.12%. Accordingly, the ratio of jobs created to jobs lost increases from 112% to 126%.

In the worst-case scenario, the adoption of online services decreases from 3% to 1.84%. The ratio of jobs created to jobs lost decreases from 112% to 96%. In this scenario, there are fewer jobs created than lost: the net impact of broadband on the employment is negative.

In a global economy, comparison with other regions of the world matters

In a global economy, the speed of adoption of online services has an impact on the number of jobs created. Accelerating the broadband development in Europe is essential to creating innovative activities and seizing the benefits of the knowledge society. Too slow a development, compared to other regions of the world, would result in a broadband-related net loss of jobs due to outsourcing and process optimization.

6.2.3 The impact on employment and GDP

Between 2006 and 2015, net job creation in the base scenario increases slightly, because the share of the business services in the economy grows (see Table 22). The contribution to GDP growth remains stable.

In the best-case scenario, net job creation increases and has an impact on the annual GDP growth.

In the worst-case scenario, the impact on employment is negative when the ratio of jobs created to jobs lost is below 100%. Even when jobs are lost, the displacement of more than 1 million jobs each year from low-productivity sectors of the economy to high-productivity sectors will yield an increase in GDP of 0.37%.

EU27	2006			2010			2015		
	Best case	Base case	Worst case	Best case	Base case	Worst case	Best case	Base case	Worst case
Adoption of online services	3%	3%	3%	3.50%	3%	2.47%	4.12%	3%	1.82%
Net jobs creation (000s jobs/year)	103	103	103	192	107	37	339	110	-20
Contribution to GDP growth	0.71%	0.71%	0.71%	0.87%	0.71%	0.55%	1.09%	0.71%	0.37%

Table 22 – Results of the scenario: impact of broadband on the economy (per year)

The results above are cumulative over the years. In the base case, a total of 1,076,000 jobs will be created between 2006 and 2015 (see Figure 74). In the worst case, broadband development will result in a creation of 345,000 jobs in Europe between 2006 and 2015; while in the best case, 2,112,000 jobs could be created.

In all three scenarios, the impact of broadband development on GDP is positive (see Figure 75). In the base case, the European GDP will have a broadband-related increase of € 850 bn between 2006 and 2015. In the worst case, broadband-related effects would result in an increase in GDP of only € 636 bn by 2015; while in the best case, € 1,080 bn cumulative GDP growth could be achieved.

Figure 74 – Broadband-related employment growth (EU27) 2006-2015 (cumulative)

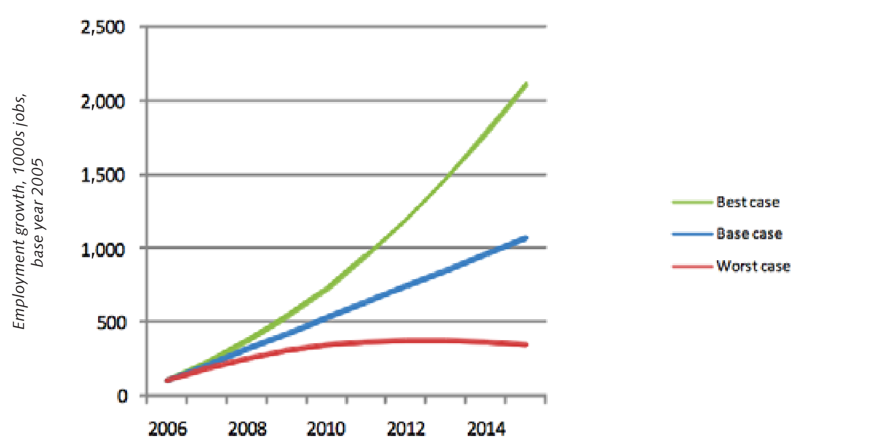
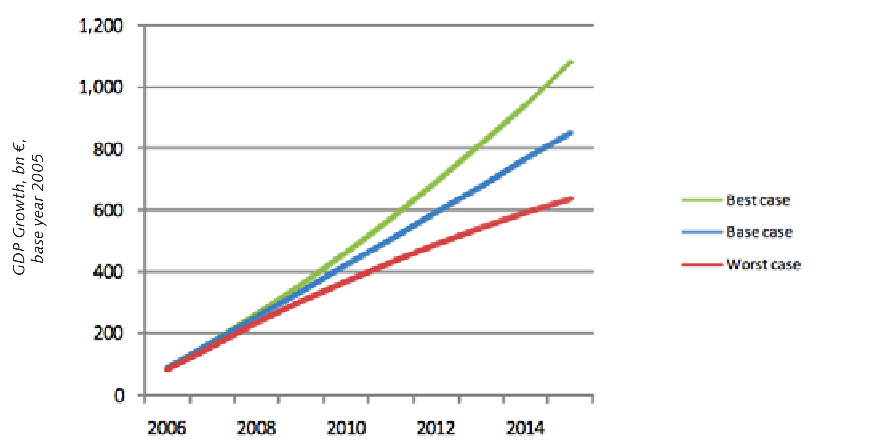


Figure 75 – Broadband-related GDP growth (EU27) 2006-2015 (cumulative)



7 Recommendations

The development of the broadband infrastructure, a high education level, the adoption of online services and the support to innovation are four essential strategic lines for the improvement of the economic impact of broadband in Europe. The concrete implementation of these strategic lines depends on the level of broadband development in each country.

The recommendations below are aimed at maximizing the economic benefits from broadband and the development of the knowledge society in each European member state.

7.1 Develop the broadband infrastructure

The development of the broadband infrastructure should foster innovation

The development of European businesses should not be impeded by insufficient broadband infrastructure. Rather, the broadband infrastructure in Europe should foster innovation.

At a low level of broadband development, broadband access should be guaranteed in the most important points in urban areas (universities, public libraries, large companies). If possible, these points should be equipped with access to the fibre-optic infrastructure, in order to remain on par with the most advanced regions of the world.

In the next development steps, priorities should progressively be set to tackle broadband coverage in suburban, rural and remote areas, in order to increase e-inclusion. Whenever possible, demand-driven levers should be used to encourage private parties to invest in the development of the infrastructure.

This infrastructure development can be achieved through an efficient private market, without the need for public financing. Policies, though, should guarantee that the market-monitoring agencies have enough power to fulfil their mission.

Nevertheless, not lagging behind other regions of the world in the development of the broadband infrastructure development is only the minimum required to take advantage of broadband. A successful broadband strategy should aim to be at the forefront of the worldwide broadband development, in order to promote innovative use of the digital network. To that aim, the development of mobile broadband networks and FTTH infrastructure are major challenges for a successful development of the knowledge society in Europe. Such ambitious development is not possible without an efficient and clear strategy from political authorities.

7.2 Rely strongly on education for long-term development of the knowledge society

Education is crucial to the development of the knowledge society and the achievement of broadband-related economic benefits.

Developing competencies in science and technology is essential

In an early stage of the development of the knowledge society, a rapid increase in the quantity and quality of the available competencies in science and technology is crucial. To that aim, it is necessary to organize the development of education channels in science and technology, and in particular in computer technologies. If possible, the support of IT companies should increase the efficiency of this modernization of the educational system. An increase in the share of graduates in science and technology in the early stages of the knowledge society should foster the businesses' technical affinity and spread IT skills by taking advantage of their "viral" effects.

In a more advanced stage of the knowledge society, the priority should be to provide IT skills to teachers in elementary schools and lifelong learning, in order to spread a high level of IT skills through all age groups of the population.

Provide online resources for autonomous learning

Furthermore, developing autonomy in the learning process is essential to prepare students to use a quickly evolving technology in an innovative context. To that aim, professors and universities across Europe should be encouraged to provide educational content and technical resources online in their own language.

7.3 Foster the use of online technologies in businesses, public services and by individuals

Promoting the use of online services is essential to the modernization of the economy, broadband-related productivity improvement and structural change towards high value-added activities.

Develop e-government to foster the use of online services

The development of e-government is the most direct way for governments to foster the use of online services by businesses and individuals. In an early stage, example e-government services should be developed, in particular for the exchange of information between businesses and public services. In a later step, e-government processes should be made the rule, not the exception, in the exchange of information between businesses and public bodies.

Apart from the development of e-government, other policies can be set in order to foster the use of online technologies in businesses. For example:

- Foster the development of the business services sector. Business services providers are "broadband leaders": they raise broadband awareness among their customers and support them in the adoption of online technologies.
- Incite professional organizations to play a role in the adoption of online technologies. They have access to a large base of members and are also often involved in vocational training and spreading competencies: their responsibility in the adoption of online technologies among small and medium companies should not be under-valued.

7.4 Promote innovation

"Innovation is the priority"

Broadband is an enabler for technology-based innovation, both in the services sector and in the manufacturing sector. Innovation is the most important factor for economic growth in developed countries: "[In developed markets,] innovation is the priority" [33]. Innovation policies are key to getting maximum benefits from broadband development by increasing internal markets and exporting high value-added technologies and services to the rest of the world.

Modern innovation policies include:

- Promote technology transfer from laboratories or universities to companies. Foster entrepreneurship and the creation of start-ups on university campuses.
- Rely on SMBs for economic growth. Support them in the acquisition of competencies through vocational training and research. Foster professional organizations supporting SMBs.
- Promote company networks to make competencies meet. Develop networking platforms or dedicated programmes to encourage contacts and partnerships between companies from different backgrounds.
- Promote synergies between small, innovative businesses and large companies willing to develop innovative markets.
- Bring innovation back to school: improve access to new technologies and technical skills for teachers and students.

The European Union has already done a lot in that area. This effort has to be sustained, in particular to support technology-based, non-technical innovation, such as process innovation or service innovation.

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9 Annexes

9.1 Characteristics of specific broadband access technologies

9.2 Composite indicators and sub-indicators (table)

9.3 Flow chart: simplified graphical description of the model

9.4 Set of equations: detailed mathematical description of the model

9.5 Quick Calculation Tool (QCT): active simulation tool based on the model

9.6 Detailed explanation of the QCT

9.7 Construction of the infrastructure model and the related development scenario

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– Published 2008 –