The impact of broadband on growth and productivity

Annex 1: Characteristics of specific broadband access technologies

This annex is related to Chapter 1 of the main text. The annex aims to provide mainly technical background information regarding the broadband access technologies addressed in this report. Sub-section 1 focuses on ADSL technologies. Sub-section 2 is devoted to VDSL. Sub-section 3 is focusing on cable modem technology. Sub-section 4 addresses optical fiber technology deployed up to the building or even up to the home (FTTB/H). Sub-section 5 presents information about fixed wireless access technologies. Sub-section 6 is devoted to mobile technologies and in sub-section 7 we refer to other (potential) broadband access technologies, i.e. to powerline communications and satellite solutions.

1. ADSL technologies

In order to better understand the basic discussion around bringing fibre nearer to the end user we refer to the following figure characterizing the main elements of the traditional „local loop".

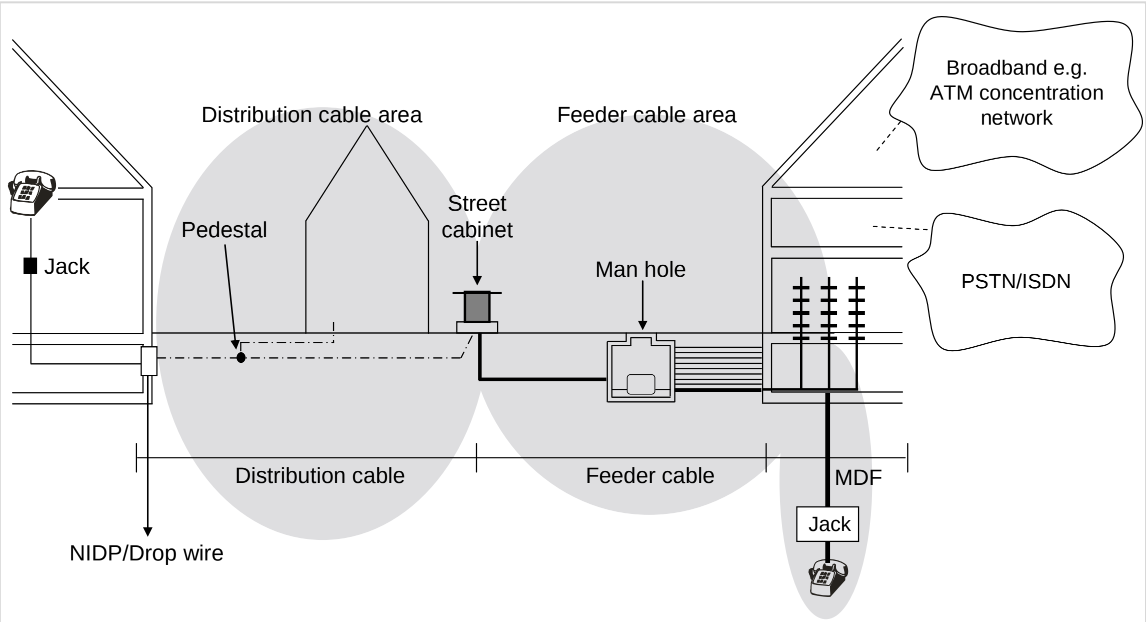

Figure 1 - The traditional „local loop": stylized facts
Source: WIK-Consult

The figure shows on the left hand side the end user's home with the telephone jack. Going to the right it provides the main elements of the PSTN-type local loop:

- *Network interface demarcation point (NIDP)*. Roughly speaking, this device mirrors the "end point" of the telephony network on the user's side.
- *Pedestal*. At this location copper lines from different end users in a particular neighbourhood come together, i.e. each NIDP of the respective end users is connected by a twisted pair copper line (the drop wire) to the pedestal. This bundle of copper lines is then linked to the street cabinet. The part of the local loop between the NIDP of end users and the street cabinet is called distribution cable.
- *Street cabinet.* The street cabinet is the first aggregation point in the access network, i.e. several bundles of copper cables are merged into one single cable, the feeder cable. The feeder cable links the street cabinet to the Main Distribution Frame (MDF). The feeder cable still consists of single twisted pair copper cables, which are, however, twisted into one "big" cable. A feeder cable is contained in ducts. Usually, there are man holes in the local loop, most often in the feeder

cable. If the distance between MDF and the street cabinet exceeds the physical length of a feeder cable then the need arises to extend this cable by an additional one. Man holes provide the possibility to connect two feeder cables. Moreover, they make it possible to add new copper cables in the ducts.

- *Main Distribution Frame (MDF).* Between the end user and the MDF one can still speak of a "raw " (dedicated) copper wire connecting each end user to the network. The MDF is the location where traffic is multiplexed for the first time.

Beyond the MDFs (i.e. to the right of the MDF in the above figure) the concentration network begins[1] and after that the actual backbone network.

Deploying ADSL technology essentially leaves the part of the network between the end user and the MDF as well as the MDF itself as it is. Otherwise stated, ADSL requires no additional digging. However, specific DSL technology has to be installed. At the end users side of the MDF one splitter per user is installed, separating the narrowband telephony traffic from the broadband data traffic. The latter is routed to multiplexers (DSLAMs) which additionally concentrate the broadband traffic. Having said this, the implicit assumption is that the MDFs that are to be equipped with ADSL technology are already accessible by physical "broadband" infrastructure in the concentration network (usually fibre).[2]

It is therefore not surprising that ADSL technology has been in many countries of the world the first step of incumbent telecommunications companies to increase the bandwidth of their networks available to end users beyond that of the PSTN/ISDN world. ADSL technologies provide substantially higher bandwidth than e.g. ISDN, i.e. bandwidths of up to about 15 Mbit/s (in practice), see below.

If a carrier installs ADSL technology at a particular MDF it is unlikely that he can reach all end users connected to this MDF. This is due to technical restrictions like e.g. impedance of the copper wire[3] and cross-talk effects if the copper wires are "too close" to each other.[4]

In fact, the number of users connected to MDFs varies within a country and across countries. An indication of the variance across countries is given in the following table. Figure 2 contains an overview of the number of access lines per MDF in selected European countries.

1 Usually the concentration network consists of more than one "concentration network layers".

2 This is not a matter of fact in many European countries. In these cases deployment of ADSL technology requires additional deployment of e.g. fiber in the concentration network and therefore perhaps also digging.

3 The impedance is e.g. affected by the length of the copper cable (see below), its diameter and its physical quality.

4 In more detail, this holds true of the dedicated copper wires of those customers who have subscribed to broadband services.

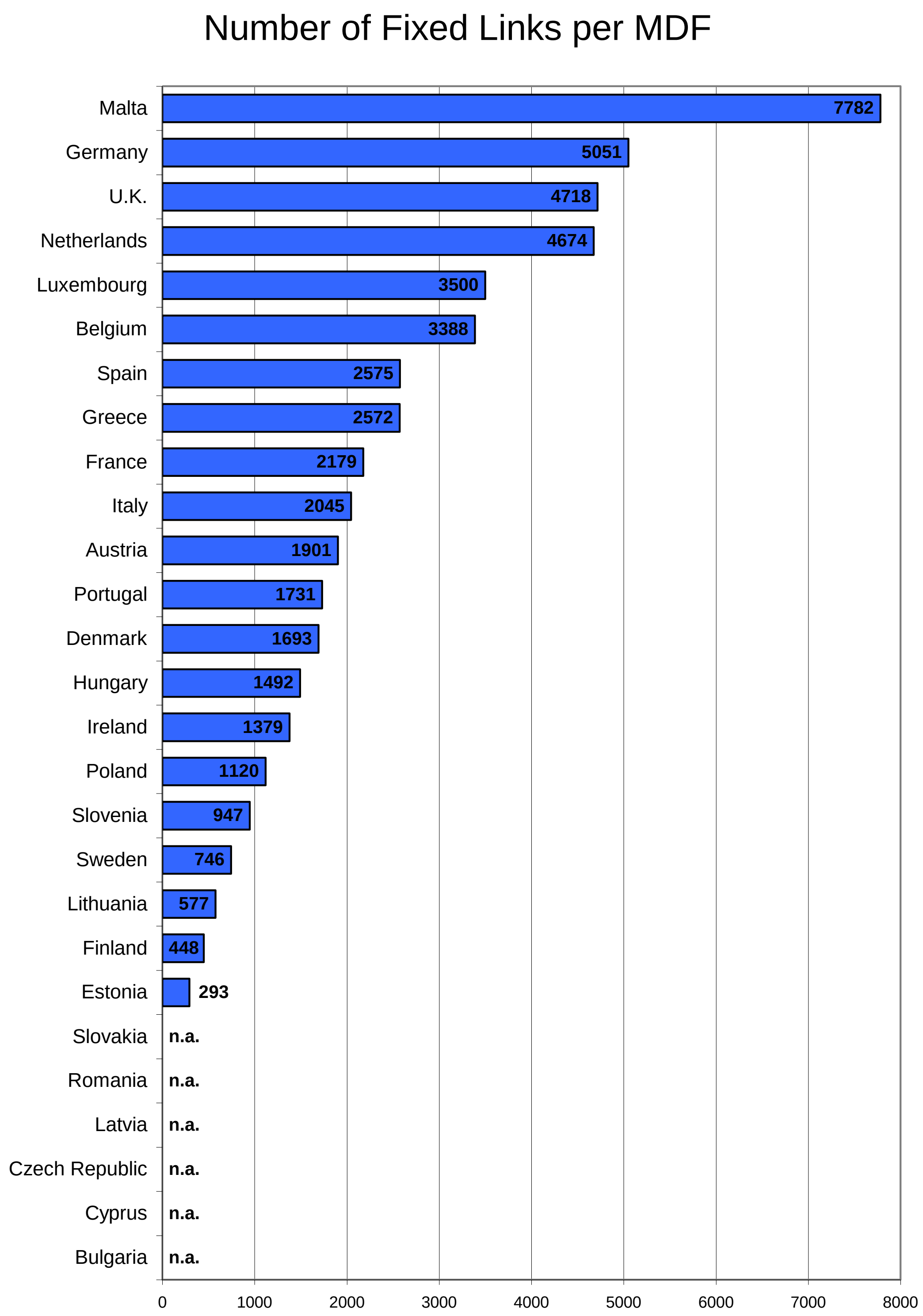

Figure 2 - Number of fixed links per MDF
Source: WIK calculation; based on: ECTA, Broadband Scorecard 2007

Despite its undisputed advantages regarding ease of deployment there is a substantial disadvantage of ADSL: the available bandwidth. Regarding the available bandwidth the most important limiting factor is the length of the local loop, i.e. the length of the link between MDF and the NIDP at the end user’s premise. The following **Fehler! Verweisquelle konnte nicht gefunden werden.** provides an overview of the relationship between available bandwidth and length of haul for different broadband access technologies.[5]

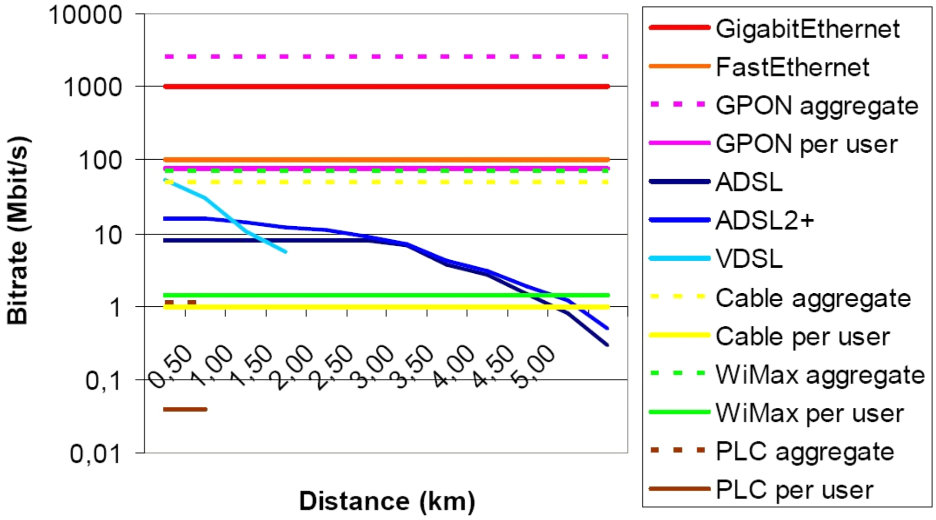

Figure 3 - Different broadband access technologies and the relationship between distance and bit-rate
Source: Fischer, W., Cisco Systems, paper presented at the Conference „Why fibre, why now?“, Brussels, May 25-26, 2004

The figure takes account of the following technologies: Ethernet, passive optical network (PON), DSL, cable modem, WiMax, and powerline. The figure shows that ADSL2+ technology can provide bandwidths up to about 20 Mbit/s; pure ADSL delivers only bandwidth below 10 Mbit/s.

2. VDSL (in comparison to ADSL)

In a VDSL environment fibre strands are deployed between today's MDF location and the street cabinet (henceforth called Fiber to the Curb, FTTC) so that only the part of the network between the street cabinet and the end user ("sub-loop") consists of copper lines. In this case the respective DSL multiplexers are installed at the street cabinet. VDSL/FTTC deployment does therefore implicitly entail that the function of an MDF is no longer needed.[6] FTTC infrastructure is visualized in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

5 See also next section where ADSL 2+ and VDSL2 are compared.

6 KPN in the Netherlands is e.g. using the sale of MDF locations as one vital instrument to finance the investment costs associated with VDSL/FTTC deployment. For competitors the closing down of MDFs brings about the risk of stranded investment, a topic high on the agenda of the regulatory discussion surrounding Next Generation Access Networks.

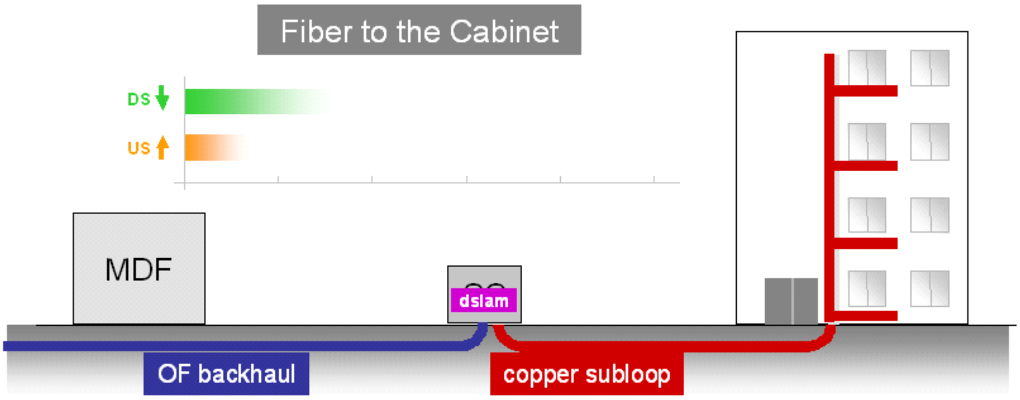

Figure 4 - FTTC infrastructure (stylized facts)
Source: G. Gauthey, Presentation at WIK VDSL-Conference, March 22, 2007

Many carriers, especially telco incumbents, are currently underway to deploy VDSL infrastructure. Examples are Belgacom in Belgium, Deutsche Telekom in Germany, Telecom Italia in Italy and KPN in the Netherlands.

The crucial factor for the upstream and downstream capacity actually available for an end user in a VDSL environment is the lengths (distance) and the diameter of the copper line. **Fehler! Verweisquelle konnte nicht gefunden werden.** provides an overview of the relationship between distance and bit-rate across different DSL technologies.

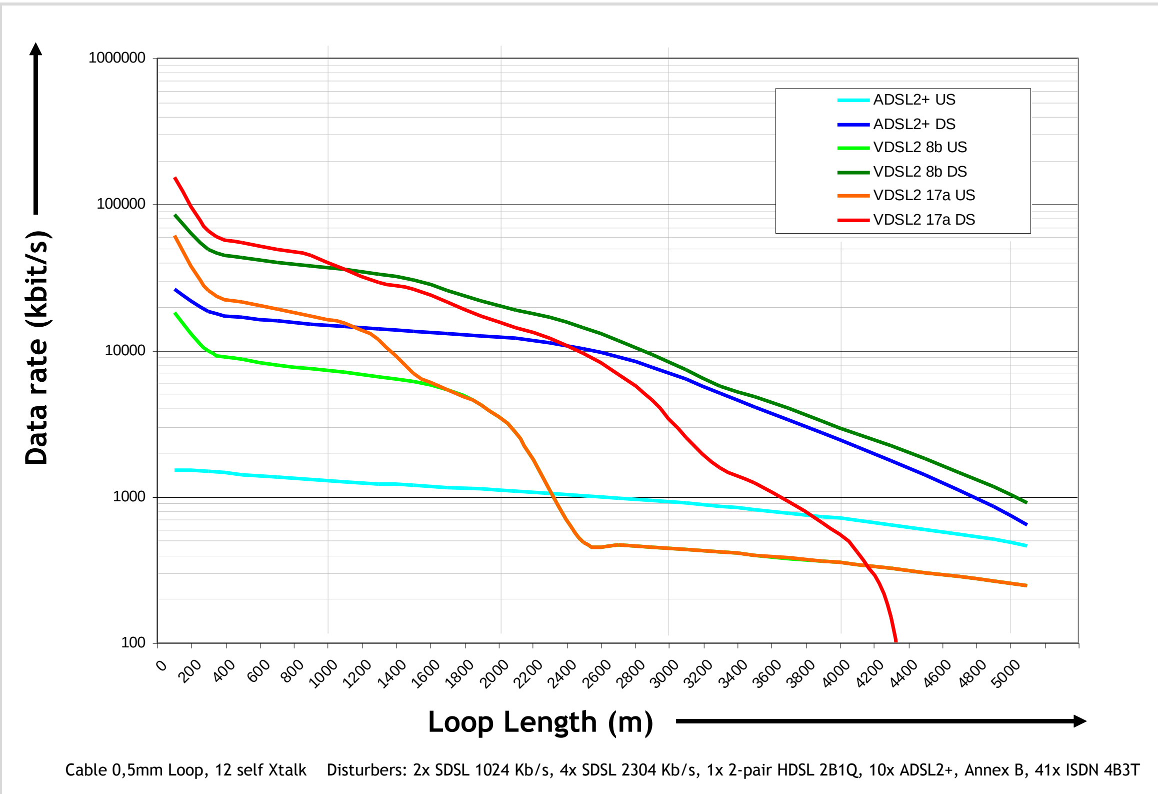

Figure 5 - ADSL2+ and VDSL technologies and the relationship between distance and bitrate
Source: Wulf; WIK VDSL Conference 21 March 2007

The figure is measured on a logarithmic scale. US and DS stand for “Upstream” and “Downstream”. The calculations condensed in this figure rest on specific technical parameters of the infrastructure outlined at the bottom of the figure (see text below “Loop Length”) and they provide information about actually available bit rates.[7] The following conclusions can be drawn from the figure.

- ADSL 2+
    - The upstream bit-rate is relatively low (less than 2 Mbit/s) and also relatively insensitive regarding distance (up to about 2.5 km the bit rate is still 1 Mbit/s).
    - The downstream bit-rates, however, are much higher (more than 20 Mbit/s for very short distances up to about 200 m and at least 10 Mbit/s for distances up to about 2.5 km).
    - ADSL 2+ looses most of its advantages over “pure” ADSL technology regarding downstream bit rates for distances beyond 3 km.
- VDSL 2+
    - Available bit-rates are sometimes much higher than those provided by ADSL 2+ for relatively low loop lengths. The VDSL 2+ 8b standard provides upstream data rates of at least 6 Mbit/s up to about 1.5 km. For very short distances (up to about 200 m) even more than 10 Mbit/s are possible. The VDSL 2+ 17a standard provides upstream data rates of more than 15 Mbit/s up to about 1 km. For very short distances (up to about 300 m) even more than 20 Mbit/s are possible.
    - The downstream bit-rates of VDSL 2 8b are always higher than those of ADSL 2+. Up to about 2 km 20 Mbit/s and more are reachable. VDSL 2 17 a downstream bit rates are, however, only higher than those of ADSL 2+ up to about 2.5 km. Beyond this loop length the bit rate is lower than under ADSL 2+ conditions. Up to about 1 km loop length bit rates of 40 Mbit/s and more are reachable. .

To sum up, the figure shows that VDSL technology is very sensitive regarding distance. It provides the most benefits regarding bandwidth if the distance is below about 500 m. The available bandwidths are in particular higher than those reachable with ADSL solutions if the distance is very short (less than about 250 m). On the other hand, the right tails of the different graphs exhibit that VDSL looses its main advantages in comparison to ADSL technologies for loop lengths beyond 1 km.

The economic rationality to deploy VDSL technology in a given country rests on several factors. In more detail, the crucial issue is to make a decision between a VDSL/FTTC infrastructure or a FTTB/H (Fiber to the Building/Home) infrastructure, see below. The main indicator to make this decision is costs. Important cost drivers are the existing access network architecture, loop lengths, customer density and dispersion[8], the presence of multi-dwelling units, the market share, and the investment risk.

From an incumbent carrier’s perspective VDSL technology can be seen at least for quite some time as a technology for the future provided particular conditions prevail in the specific market in which the carrier is acting. Firstly, it is obvious that (sub) local loop lengths should be “short” so that VDSL can deliver its full bandwidth. Secondly, the services and applications demanded in this market should not be “too bandwidth hungry”. Thirdly, competition regarding bandwidth should not be “too fierce” in the market, i.e. the threat for incumbent telcos that other carriers (cable or other telcos) are deploying technology capable of providing higher bandwidths than VDSL should be low.

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7 The calculations have been made by Alcatel-Lucent under conditions which are reflecting “real” network conditions in practice. Otherwise stated, they are not measured as maximum bit rates under laboratory conditions.

8 The crucial factor is the distribution of reachable subscribers depending on different loop lengths, see Section **Fehler! Verweisquelle konnte nicht gefunden werden.** for more details.

3. Cable modem

The upgrades currently carried out by cable operators require particular changes in the network topology. Indeed, the introduction of the return path and the extension of the frequency range require an exchange of all amplifiers along the cable network in the last mile. In order to increase the capacity for IP traffic, some network clusters have to be partitioned and the existing copper coaxial infrastructure has to be replaced by new fibre lines to connect these clusters with the head end. Smaller network clusters means less subscribers along the shared capacity of one coaxial line. After the replacement of certain copper coaxial cables by fibre lines, upgraded cable networks are called hybrid fibre coaxial (HFC) networks (see next figure). Broadband access in this case is provided via *cable modem.*

From this perspective, migration to broadband infrastructure in the area of cable networks and teleco networks have one thing in common: both are based of deploying optical fibre solutions in the customer access network.

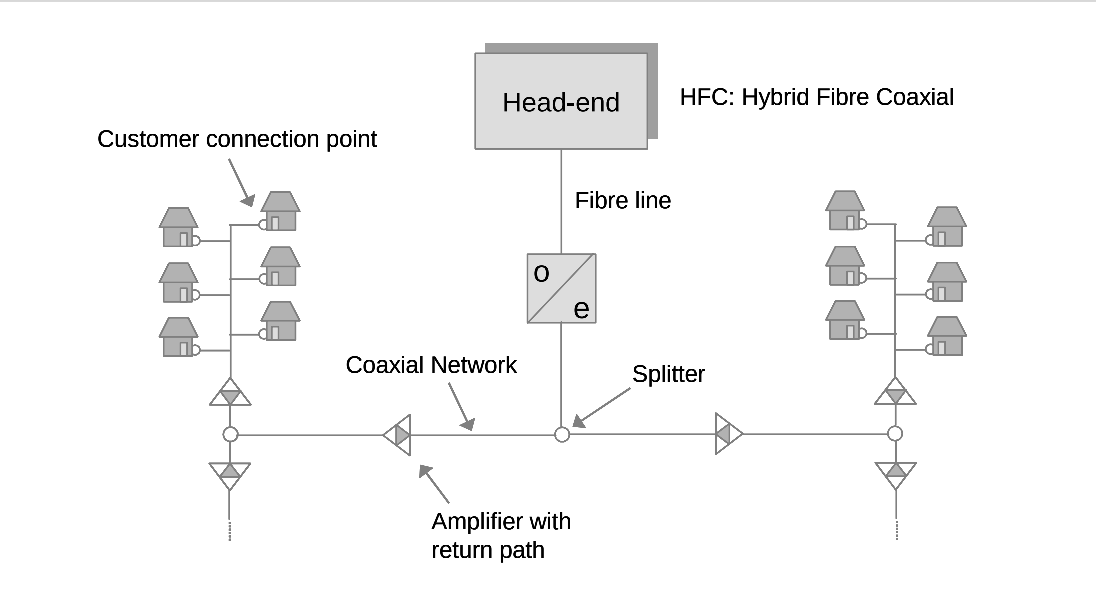

Figure 6 - Architecture of hybrid fibre coaxial cable networks
Source: WIK-Consult

4. Fiber to the Building / Fiber to the Home

If a carrier opts for a FTTB/H solution fiber is deployed up to the (basement of a) building (Fiber to the Building, FTTB) or to the end user's home (Fiber to the Home). The difference between FTTB and FTTH is in particular obvious if the homes are actually apartments in a multi-dwelling unit. FTTB and FTTH, respectively, infrastructure is visualized in the next figure.

The figure shows that MDFs and street cabinets logically are not needed anymore in a FTTB/H environment. Physically, it could however, very well be the case that previous MDF locations (of the old PSTN/ISDN world) are used to install the necessary fiber related equipment. The figure makes also obvious that FTTH provides the highest upstream (US) and downstream (DS) bandwidth to end users. The lower part of the figure shows a particular realization of a FTTH network, namely a point-to-point network architecture. In this case dedicated fiber strands are deployed between the Optical Distribution Frame and the end users. However, other architectures are possible (so called "passive optical networks).

Figure 7 - FTTB/H infrastructure (stylized facts)
Source: G. Gauthey, Presentation at WIK VDSL-Conference, March 22, 2007

Carriers using a FTTB/H approach are e.g. NTT in Japan, France Télécom and Iliad as well as local and regional initiatives in France, NetCologne (regional carrier in the region of Cologne) in Germany, Fastweb in Italy, OnsNet (in Nuenen) and CityNet (in Amsterdam) in the Netherlands, as well as local and regional initiatives in Sweden and in the UK.

It is obvious that FTTB/H deployment is very expensive if digging is required. Due to this fact, it is plausible that carriers have an incentive to seek ways to avoid digging. One alternative is aerial deployment. In countries like Japan and Korea aerial deployment of fibre at least in the distribution network (that part of the network between street cabinet and the end user) is the rule rather than the exception. Another alternative is to use already existing infrastructure from third parties which they can use. An example is the sewer infrastructure on which e.g. French FTTB/H carriers are relying to a large extent.

Although FTTB/H networks usually are a completely new infrastructure not relying any more on the old copper loop of telcos deployment costs are presumably not that high if digging can be avoided. France Télécom reports e.g. investment costs per customer of 4,000 € today which are expected to decrease to about 1,000 € after the mass market roll-out is reached.

It is fair to state that that the overall market share of FTTx is still relatively low compared to DSL and cable modem.[9]

FTTB/H technology seems to be the most future proof broadband access technology in a long term perspective. Several countries, in particular Japan and Korea[10], have launched very ambitious deployment programs focusing on deploying FTTB/H based broadband infrastructures virtually for everyone to reach the ubiquitous society.

5. Fixed wireless technologies

PWLAN

The term „wireless LAN“ (WLAN) refers to local area computer networks providing radio-based data transmission over a range of some 100 meters. Most WLANs are built using the wireless networking standard Wi-Fi. Wi-Fi (Wireless Fidelity) is a trademark owned by the Wi-Fi Alliance and refers to the family of IEEE 802.11 standards.[11] Within this family, there are different standards offering different radio technologies and data rates. WiFi operates in the ISM-bands on an "unlicensed" or "license-exempt" basis, without the need for prior regulatory approval.[12] Currently, the standards 802.11b or 802.11g operate in the ISM-band at 2.4 GHz and offer nominal (theoretical) data rates of 11 Mbit/s and 54 Mbit/s (including the packet header) per channel. The 802.11a systems operate in the 5-GHz band. It offers a nominal maximum data rate of 54 Mbit/s. The actual available maximum net data rate for the end users is, however, only equal to about 50% of the theoretical maximum rates across all systems.

There are extensions to the 802.11 standard (such as 802.11e, f, and n) that offer higher data rates, higher security, or are optimized for multimedia applications. These standards have not yet reached wide-scale adoption and may not offer the compatibility and economies of scale associated with earlier WiFi standards. While the vast majority of wireless data networks operating in the ISM bands are based on WiFi, it is important to note that there are also proprietary systems which operate in this band. One prominent example is Motorola's product Canopy. Canopy equipment operates in both 2.4 and 5.7GHz bands and has certain advantages over WiFi. These systems, however, might not be suitable for use in public networks due to a lack of compatibility to other vendors' products and wide-scale acceptance.

WIMAX

The acronym „WiMAX“ stands for Worldwide Interoperability for Microwave Access and typically refers to radio based systems utilizing the IEEE 802.16 family of standards. While the name WiMAX was created by the WiMax Forum, it is not a trademark term and can therefore be used for proprietary

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9 See e.g. Point-topic "Global Quarterly Broadband Statistics", July 5, 2007 who point out that during the first quarter of 2007, FTTx continued to out-perform cable modem in terms of quarterly growth. They continue to state that by the end of Q1 2007, the world FTTx subscriber base had reached 31.4 million lines, with a growth of 46% in the past year. Following their data base the overall market share of FTTx is still very low (10.7%), compared to DSL (66.1%) and cable modem (20.3%). However, obviously FTTx is gradually gaining ground in market share terms. From the beginning of 2005 until the end of 2006, the number of FTTx subscribers has been increasing at a rate of over 10% every quarter. In Q1 2007 this growth has slowed down by 5%, down to 5.8%. Of the seven global regions, North America (primarily the USA), and Asia-Pacific have displayed the most impressive growth rates above the average of 17.3% and 8.3% respectively during Q1 2007.
See http://point-topic.com/home/press/dslanalysis.asp

10 In Japan the number of FTTB/H customers is greater than 8 mill. (as of 2007).

11 The IEEE (Institute of Electrical and Electronics Engineers, Inc.) is a non-profit technical professional organization. Among other activities, the organization develops operating standards for communication equipment. The IEEE 802.11 Working Group, in particular, develops standards for wireless local area networking devices.

12 A distinction must be made between WiFi and unlicensed. While unlicensed/license-exempt operation is the norm for WiFi, there are certain African nations which require operators to first obtain a license.

systems, unlike the term WiFi.[13] However, “WiMAX Forum Certified” is a trademark term and can only be used with the permission of the Forum. Similar to WLAN, several different WiMAX standards with different operational characteristics also exist. These different versions of the 802.16 protocols within the IEEE family of standards are suited to different types of applications and deployments. Systems built using 802.16-2004 (sometimes mistakenly referred to as ‘802.16d’) as the air interface technology are “Fixed WiMAX” and systems built using 802.16e-2005 as the air interface technology are “Mobile WiMAX”. The currently most widely used standard for such a radio based transmission, 802.16-2004, comprises the essential elements of the earlier standards 802.16a and 802.16d. WiMAX implementations are frequently used to deliver purely fixed services, where each base station covers a broad area within a Metropolitan Area Network (MAN).

One of the most important features distinguishing the standards is its operational frequency range which greatly impacts its range and whether or not it can offer line-of-sight operation. Line-of-sight operation is possible in the frequency ranges above 11 GHz. These systems are often used to provide point-to-point links for wireless access from base stations to the core network. Non-line-of-sight operation is applicable e.g. up to about 6 GHz, in particular regarding provision of end users).

General discussion

Sometimes it is argued in the market (e.g. in Germany) that hybrid mobile network technologies (like *T-DAB, DVB-T, DVB-H*) could also be used for broadband access. However, we do not take account of these technologies in this study. The reason is the following: Frequencies for these technologies are awarded “technology neutral” so that the respective licensee (network operator/service provider) has the right to decide on the technology to be used. We believe however, that a licensee will have no incentive to use these broadcasting technologies for broadband access.

It is obvious that fixed wireless access technologies are based on a substantially different cost model than fixed wireline technologies discussed so far. In particular, by definition they do not require digging and, thus, one could think at first sight that they have a cost advantage. However, it is fair to state that in those countries with a high DSL coverage WiMax will not be a viable business case (for the mass market). This has been proven by several field trials and it is also reflected in the fact that in those countries with a high DSL coverage participation by telcos in the WiMax frequency allotment was very low. WiMax provides advantageous applications in regions difficult to access (e.g. islands, mountains) and it is of course an alternative in areas (of countries) where no PSTN/ISDN infrastructure exists.

6. Mobile broadband technologies[14]

There are several technologies providing broadband access via mobile technologies. In the frame of this study we focus mainly on UMTS based access technologies. Two alternatives are in principle important:

- PortableDSL//UMTS-TDD (Time Division Duplex)
- UMTS-FDD (Frequency Division Duplex).

PortableDSL is a wireless access technology based on Release 99 of the UMTS standard, however, it uses the TDD procedure to separate uplink and downlink. As in the case of the FDD based approach W-CDMA technology is utilized. As a UMTS based standard, PortableDSL rests on cellular technology and provides both a good inhouse provision of services and a high degree of mobility (provided an appropriate coverage of an area).

[13] WiMAX and WiFi are often confused since they are both IEEE 802 standards and sound similar. However their implementations are extremely different.

[14] This section is based on Büllingen et al. (2006).

The current UMTS mobile networks are based on the UMTS-FDD standard Release 99. These networks offer the mobile transmission of voice and data. UMTS-FDD rests on W-CDMA for the modulation procedure and uses two paired 5-MHz frequency channels to separate uplink and downlink, whereby the carrier frequencies (the signal on which modulation takes place) are in the 2-GHz band. This system is very flexible: Besides connection oriented transmissions with different data rates it offers also the possibility to operate packet oriented connections with different data rates. The system in particular provides for full mobility (provided the appropriate coverage of an area). The current maximum data rate for an end user is 348 Kbit/s.

However, since 2006 mobile network carriers are deploying more and more technologies which are updates of the original technology. These updates are specified in Release 6 of the UMTS standard (High Speed Packet Access, HSPA) and they are providing much higher data rates than the original UMTS standard. One can distinguish HSDPA for the downlink and HSUPA for the uplink. Theoretically, (gross) data rates (i.e. the data rate which is shared among all users within a specific cell) of up to 14.4 Mbit/s currently are (technically) available (for the downlink). However, it is more realistic to assume (practically available) data rates of 2 – 3.5 Mbit/s (depending e.g. on the actual quality of the radio channel, the utilization rate of the cell, and the distribution and mobility of the users).

In principle HSDPA supports mobility features of the original UMTS system. However, it is fair to state that the accessible data rates for an individual user can decrease substantially with an increasing distance to the base station.

Coverage of mobile broadband technologies is differing across Europe. In many countries in Europe at least 60 % of the population can be reached by mobile broadband technologies.

It is foreseeable that many new, innovative applications will be developed in the next years based on mobile broadband infrastructures. Presumably, fixed and mobile Internet take reciprocally advantage from one another. Although it is likely to be a quickly expanding market which might very well entail further productivity increases in the economy mobile applications and services will not be considered in this study because it is too early to make sound estimates.

Despite their cost, mobile technologies seem to have an opportunity when no other reliable broadband infrastructure is available (see e.g. Romania).

7. Other broadband access technologies

The currently used standard for digital satellite broadcasting (DVB-S) allows beside the transmission of video and audio signals the transmission of broadband data. Generally, one can distinguish two types of satellite Internet solutions

- One way with terrestrial return, and
- Two way satellite Internet access.

One way with terrestrial return satellite Internet systems use terrestrial connections like POTS or ISDN connections for the up-stream link. The downstream link, however, is realized via satellite. The maximum downlink speeds reachable are between 256 Kbit/s and 20 Mbit/s. The available uplink bandwidths vary with the used technology. If ISDN is used uplink speeds up to 128 Kbit/s are possible.

Two way satellite Internet services use satellite connections for both uplink and downlink. The maximum downlink speed varies – depending on the provider - between 64 Kbit/s and 20 Mbit/s The maximum uplink speed varies for retail customers between 64 Kbit/s and 1 Mbit/s. Because of higher costs and technical competencies needed to implement this technology, two-ways internet satellite connection was until now principally used by professional users in remote areas such as off-shore oil platforms, local internet service providers or logistics facilities.

At the beginning of 2007, the satellite telecommunications provider ASTRA launched a new satellite equipped with the ASTRA2Connect technology, specially designed to allow internet connections for individual users. This satellite covers all EU27 countries. This technology enables commercial offers with prices similar to DSL, with a download bandwidth of 256kbit/s, or 1Mbit/s (DL) for twice the price, without initial investment from the subscriber (http://www.yato.de/bestell/). ASTRA does not have a commercial partner in each European country yet: it is a new service, that should develop over the next years. Satellite internet, like mobile internet, offers a shared bandwidth. It should be expected that the quality of the service will decrease with the number of users.

The main disadvantage of satellite Internet solutions is its inherent latency. Two way satellite Internet service latency can be up to one second, which is e.g. five times as high as that of a modem connection. Moreover, the scarcity of satellites with free capacity has to be kept in mind as well as the scarcity of orbital positions.

Powerline

At first glance powerline seems to offer benefits relative to cable or DSL connections. Indeed, the argument could be that the physical electricity network is already available, thus, allowing people in remote locations to get access to the Internet with relatively little additional investment in new facilities and equipment. However, actually there are variations in the physical characteristics of the electricity networks and there is a lack of standards. [15] In effect this means that provisioning of a broadband access service is far from being a standardized, repeatable process and the amount of bandwidth a powerline system can provide compared to cable and wireless solutions is in question.

Powerline has its benefits in particular for in-house cabling because the physical electricity network usually makes every room in an apartment/building accessible. The latter is e.g. relevant if a carrier has deployed fibre to the basement and wants to get access to the different apartments in a multi-dwelling unit.

Some groups oppose the proliferation of powerline technology in particular due to its potential to interfere with radio transmissions. The reason is that power lines usually are untwisted and unshielded. Due to this lack of shielding, the power lines run also the risk of interference by outside radio signals.

15 Several organisations currently are involved in standardisation efforts including the HomePlug Powerline Alliance, the Universal Powerline Association, ETSI, and the IEEE. It is unclear which standard finally will evolve.

Annex 2: Composite indicators and sub-indicators

		Country group	Broadband readiness	x100	Infrastructure	x100	Use of services	x100	Broadband readiness PC penetration in househ	
2006									Category 1	Data 2006
EU (25 count	EU25		68.42%	68.4172964	50.10%	50.1046097	23.06%	23.0626452	72.54%	61.51%
EU (15 count	EU15		69.13%	69.1290875	53.46%	53.461178	24.00%	23.9960948	75.84%	64.31%
Belgium	BE	4	69.59%	69.5892253	61.36%	61.360691	23.40%	23.401014	67.76%	57.45%
Bulgaria	BG	1	43.64%	43.6382896	34.68%	34.6805672	10.20%	10.2016003	25.01%	21.20%
Czech Repub	CZ	2	53.80%	53.8002879	40.05%	40.0483483	21.32%	21.3230198	46.04%	39.04%
Denmark	DK	4	87.46%	87.4647238	63.31%	63.3087038	38.22%	38.2214504	100.00%	84.79%
Germany	DE	3	82.80%	82.7982154	55.64%	55.6392937	27.93%	27.9263256	90.55%	76.77%
Estonia	EE	2	70.58%	70.578496	41.87%	41.8657148	25.59%	25.5893406	60.97%	51.70%
Ireland	IE	2	61.36%	61.3591655	44.11%	44.1084406	28.94%	28.9352492	69.01%	58.51%
Greece	EL	1	44.39%	44.3892647	22.70%	22.702748	19.69%	19.6866221	43.26%	36.67%
Spain	ES	3	67.02%	67.0224953	47.96%	47.9580426	17.65%	17.6544753	67.17%	56.95%
France	FR	3	69.49%	69.4884958	50.16%	50.1584871	23.21%	23.2090338	66.47%	56.36%
Italy	IT	3	56.33%	56.3264835	45.41%	45.4094035	14.33%	14.332094	56.14%	47.60%
Cyprus	CY	1	50.62%	50.6168553	27.62%	27.6241047	12.48%	12.4788075	61.23%	51.91%
Latvia	LV	1	49.32%	49.3152716	25.99%	25.9909382	12.59%	12.587966	47.88%	40.60%
Lithuania	LT	2	47.81%	47.8070101	39.76%	39.7640584	20.32%	20.3155053	46.91%	39.77%
Luxembourg	LU	4	79.84%	79.8374584	64.13%	64.1337238	23.52%	23.5188228	90.91%	77.08%
Hungary	HU	2	60.07%	60.068854	47.30%	47.2984983	13.71%	13.7093735	58.42%	49.53%
Malta	MT	2	61.43%	61.4313279	64.96%	64.9602419			71.47%	60.60%
Netherlands	NL	4	89.74%	89.7378581	69.22%	69.2234137	29.53%	29.5274292	94.40%	80.04%
Austria	AT	4	74.10%	74.1031848	53.19%	53.1877884	24.70%	24.6991208	78.83%	66.83%
Poland	PL	1	45.95%	45.9463057	25.89%	25.8929274	15.72%	15.7160112	53.44%	45.31%
Portugal	PT	2	52.75%	52.7489129	54.53%	54.5333867	16.47%	16.4655052	53.56%	45.41%
Romania	RO	1	39.72%	39.723866	33.74%	33.7390192	8.34%	8.34421688	30.39%	25.77%
Slovenia	SI	2	68.76%	68.7646843	35.08%	35.0818015	23.82%	23.8246424	76.49%	64.85%
Slovakia	SK	1	50.76%	50.7561079	29.80%	29.8036303	21.70%	21.6994439	59.05%	50.07%
Finland	FI	4	90.06%	90.0637456	57.52%	57.5246616	30.23%	30.2266581	83.83%	71.07%
Sweden	SE	4	92.66%	92.6640039	60.97%	60.9740087	35.39%	35.3948997	97.26%	82.46%
United Kingd	UK	3	72.03%	72.033282	63.84%	63.8377816	28.42%	28.423293	84.21%	71.40%

			Cronbach Alpha:		0.753						
		Technical competences, Composite indicator					**Early access points**				
			IT skills, high (% pop)		HRST			Large companies (BB pene		Schools (BB penetration, %	
2006		**Category 2**	Normalized	Data 2006	Normalized	Data 2005	**Category 3**	Normalized	Data 2006	Normalized	Data 2006
EU (25 count	EU25	68.46%	57.89%	22.00%	79.03%	46.24%	82.86%	95.37%	95.37%	70.35%	66.90%
EU (15 count	EU15	72.03%	63.16%	24.00%	80.91%	47.34%	85.94%	96.17%	96.17%	75.71%	72.00%
Belgium	BE	78.95%	57.89%	22.00%	100.00%	58.51%	87.03%	96.46%	96.46%	77.60%	73.80%
Bulgaria	BG	44.49%	15.79%	6.00%	73.20%	42.83%	81.21%	81.21%	81.21%		
Czech Repub	CZ	52.67%	36.84%	14.00%	68.49%	40.07%	78.98%	92.14%	92.14%	65.83%	62.60%
Denmark	DK	95.11%	100.00%	38.00%	90.23%	52.79%	98.26%	96.51%	96.51%	100.00%	95.10%
Germany	DE	82.45%	71.05%	27.00%	93.84%	54.90%	81.14%	96.14%	96.14%	66.14%	62.90%
Estonia	EE	81.29%	65.79%	25.00%	96.80%	56.63%	98.12%	96.35%	96.35%	99.89%	95.00%
Ireland	IE	62.70%	50.00%	19.00%	75.39%	44.11%	79.96%	90.41%	90.41%	69.51%	66.10%
Greece	EL	52.06%	42.11%	16.00%	62.01%	36.28%	52.61%	91.34%	91.34%	13.88%	13.20%
Spain	ES	70.90%	60.53%	23.00%	81.27%	47.55%	91.66%	98.46%	98.46%	84.86%	80.70%
France	FR	70.83%	55.26%	21.00%	86.40%	50.55%	87.39%	96.12%	96.12%	78.65%	74.80%
Italy	IT	54.70%	44.74%	17.00%	64.66%	37.83%	83.84%	95.13%	95.13%	72.56%	69.00%
Cyprus	CY	62.33%	50.00%	19.00%	74.65%	43.68%	65.42%	98.25%	98.25%	32.60%	31.00%
Latvia	LV	51.01%	31.58%	12.00%	70.44%	41.21%	76.60%	83.27%	83.27%	69.93%	66.50%
Lithuania	LT	60.83%	42.11%	16.00%	79.55%	46.54%	58.41%	82.53%	82.53%	34.28%	32.60%
Luxembourg	LU	91.95%	94.74%	36.00%	89.17%	52.17%	88.79%	97.14%	97.14%	80.44%	76.50%
Hungary	HU	65.93%	65.79%	25.00%	66.06%	38.65%	86.10%	90.80%	90.80%	81.39%	77.40%
Malta	MT	55.09%	52.63%	20.00%	57.55%	33.67%	99.37%			99.37%	94.50%
Netherlands	NL	90.12%	86.84%	33.00%	93.40%	54.64%	95.66%	95.00%	95.00%	96.32%	91.60%
Austria	AT	78.40%	81.58%	31.00%	75.22%	44.01%	84.29%	96.97%	96.97%	71.61%	68.10%
Poland	PL	47.68%	28.95%	11.00%	66.42%	38.86%	60.92%	92.49%	92.49%	29.34%	27.90%
Portugal	PT	47.27%	55.26%	21.00%	39.27%	22.98%	87.33%	98.10%	98.10%	76.55%	72.80%
Romania	RO	27.67%	13.16%	5.00%	42.17%	24.67%	69.34%	69.34%	69.34%		
Slovenia	SI	73.22%	73.68%	28.00%	72.75%	42.56%	93.38%	97.59%	97.59%	89.17%	84.80%
Slovakia	SK	55.28%	44.74%	17.00%	65.82%	38.51%	60.58%	79.52%	79.52%	41.64%	39.60%
Finland	FI	86.93%	76.32%	29.00%	97.53%	57.06%	96.07%	97.60%	97.60%	94.53%	89.90%
Sweden	SE	84.58%	78.95%	30.00%	90.20%	52.78%	96.33%	99.07%	99.07%	93.59%	89.00%
United Kingd	UK	71.00%	68.42%	26.00%	73.58%	43.05%	87.33%	95.69%	95.69%	78.97%	75.10%

									Infrastructure		Cronbach Alp
		Innovation							**Already available broadband infrastru**		
		), EU Commi	R&D expenditures, % of GI		R&D personnel		Innovation expenditures in		SMBs, adjuste	DSL coverage (% pop)	
2006		**Category 4**	Normalized	Data 2005	Normalized	Data 2004, %	Normalized		**Category 1**	Normalized	Data 2006
EU (25 count	EU25	49.81%	47.93%	1.85	45.99%	1.49%	57.40%				
EU (15 count	EU15	42.70%	49.48%	1.91	49.07%	1.59%	22.76%				
Belgium	BE	44.62%	47.15%	1.82	55.86%	1.81%	28.30%		81.58%	100.00%	100.00%
Bulgaria	BG	23.85%	12.95%	0.5	18.83%	0.61%	50.65%		20.53%		
Czech Repub	CZ	37.51%	36.79%	1.42	39.51%	1.28%	36.95%		53.13%	81.00%	81.00%
Denmark	DK	56.49%	63.21%	2.44	74.38%	2.41%	25.15%		74.21%	100.00%	100.00%
Germany	DE	77.05%	65.03%	2.51	57.10%	1.85%	121.07%		57.52%	93.00%	93.00%
Estonia	EE	41.92%	24.35%	0.94	39.51%	1.28%	79.48%		55.79%		
Ireland	IE	33.77%	32.38%	1.25	43.21%	1.40%	27.12%		49.71%	86.00%	86.00%
Greece	EL	29.63%	15.80%	0.61	41.36%	1.34%	45.57%		18.25%	18.00%	18.00%
Spain	ES	38.37%	29.02%	1.12	45.99%	1.49%	49.46%		69.60%	90.00%	90.00%
France	FR	53.27%	55.18%	2.13	52.78%	1.71%	49.92%		61.43%	98.00%	98.00%
Italy	IT	30.62%	28.50%	1.1	34.88%	1.13%			50.93%	89.00%	89.00%
Cyprus	CY	13.49%	10.36%	0.4	19.75%	0.64%			37.95%	70.00%	70.00%
Latvia	LV	21.77%	14.77%	0.57	25.00%	0.81%	32.56%		2.11%		
Lithuania	LT	25.09%	19.69%	0.76	31.17%	1.01%	29.79%		69.42%	82.00%	82.00%
Luxembourg	LU	47.70%	40.41%	1.56	68.21%	2.21%	41.75%		78.60%	100.00%	100.00%
Hungary	HU	29.84%	24.35%	0.94	39.20%	1.27%	31.44%		78.74%	88.00%	88.00%
Malta	MT	19.79%	15.80%	0.61	27.78%	0.90%			99.50%	99.00%	99.00%
Netherlands	NL	78.77%	45.60%	1.76	40.74%	1.32%	25.61%		83.75%	99.00%	99.00%
Austria	AT	54.90%	61.14%	2.36	54.63%	1.77%	42.69%		60.81%	86.00%	86.00%
Poland	PL	21.75%	14.77%	0.57	28.40%	0.92%	29.08%		29.79%	67.00%	67.00%
Portugal	PT	22.84%	20.98%	0.81	26.54%	0.86%			77.29%	94.00%	94.00%
Romania	RO	31.51%	10.10%	0.39	13.89%	0.45%	28.91%		17.63%		
Slovenia	SI	31.98%	31.61%	1.22	32.72%	1.06%			35.76%	61.00%	61.00%
Slovakia	SK	28.11%	13.21%	0.51	31.48%	1.02%	54.54%		41.84%	70.00%	70.00%
Finland	FI	93.44%	90.16%	3.48	100.00%	3.24%			62.84%	90.00%	90.00%
Sweden	SE	92.49%	100.00%	3.86	77.47%	2.51%			78.07%	95.00%	95.00%
United Kingd	UK	45.60%	45.60%	1.76					79.10%	99.00%	99.00%

		ha:	0.761								
		cture				**Traditional network infrastructure**					
		Cable modem coverage		UMTS coverage			Fixed link penetration		Cable TV penetration		Inhabitants p
2006		Normalized	Data 2006	Normalized	Data 2005	**Category 2**	Normalized	Data 2006	Normalized	Data 2004	Normalized
EU (25 count	EU25										
EU (15 count	EU15										
Belgium	BE	84.21%	80.00%	60.54%	60.54%	70.46%	53.74%	31.07%	100.00%	91.00%	57.63%
Bulgaria	BG	21.05%	20.00%	20.00%	20.00%	57.96%	58.77%	33.97%	57.14%	52.00%	
Czech Repub	CZ	25.26%	24.00%			34.19%	45.30%	26.19%	23.08%	21.00%	
Denmark	DK	63.16%	60.00%	59.46%	59.46%	49.03%	65.07%	37.61%	58.24%	53.00%	23.78%
Germany	DE	15.79%	15.00%	63.78%	63.78%	66.80%	83.67%	48.36%	61.54%	56.00%	55.19%
Estonia	EE	55.79%	53.00%			33.25%	49.24%	28.46%	45.05%	41.00%	5.45%
Ireland	IE	4.21%	4.00%	58.92%	58.92%	40.96%	72.53%	41.92%	32.97%	30.00%	17.39%
Greece	EL	0.00%	0.00%	36.76%	36.76%	37.56%	85.00%	49.13%	0.00%	0.00%	27.67%
Spain	ES	44.21%	42.00%	74.59%	74.59%	38.21%	74.06%	42.81%	8.79%	8.00%	31.79%
France	FR	27.37%	26.00%	58.92%	58.92%	40.79%	84.52%	48.86%	14.29%	13.00%	23.57%
Italy	IT	0.00%	0.00%	63.78%	63.78%	32.44%	70.98%	41.03%	0.00%	0.00%	26.33%
Cyprus	CY	5.89%	5.60%			45.09%	90.18%	52.13%	0.00%	0.00%	
Latvia	LV	2.11%	2.00%			35.11%	47.14%	27.25%	23.08%	21.00%	
Lithuania	LT	56.84%	54.00%			25.68%	37.80%	21.85%	25.27%	23.00%	13.96%
Luxembourg	LU	35.79%	34.00%	100.00%	100.00%	65.09%	90.81%	52.49%	69.23%	63.00%	35.23%
Hungary	HU	69.47%	66.00%			43.89%	42.27%	24.43%	57.14%	52.00%	32.27%
Malta	MT	100.00%	95.00%			84.52%	71.14%	41.12%	82.42%	75.00%	100.00%
Netherlands	NL	86.32%	82.00%	65.95%	65.95%	75.84%	67.79%	39.19%	96.70%	88.00%	63.03%
Austria	AT	32.63%	31.00%	63.78%	63.78%	44.46%	60.87%	35.19%	43.96%	40.00%	28.56%
Poland	PL	12.63%	12.00%	9.73%	9.73%	29.75%	38.45%	22.22%	24.18%	22.00%	26.63%
Portugal	PT	78.95%	75.00%	58.92%	58.92%	36.90%	53.87%	31.14%	27.47%	25.00%	29.38%
Romania	RO	5.26%	5.00%	30.00%	30.00%	41.58%	43.60%	25.20%	39.56%	36.00%	
Slovenia	SI	10.53%	10.00%			41.63%	61.34%	35.46%	49.45%	45.00%	14.11%
Slovakia	SK	13.68%	13.00%			30.97%	34.48%	19.93%	27.47%	25.00%	
Finland	FI	34.74%	33.00%	63.78%	63.78%	48.37%	88.86%	51.37%	51.65%	47.00%	4.61%
Sweden	SE	49.47%	47.00%	89.73%	89.73%	54.65%	100.00%	57.80%	57.14%	52.00%	6.82%
United Kingd	UK	50.74%	48.20%	87.57%	87.57%	49.11%	77.16%	44.60%	14.29%	13.00%	55.89%

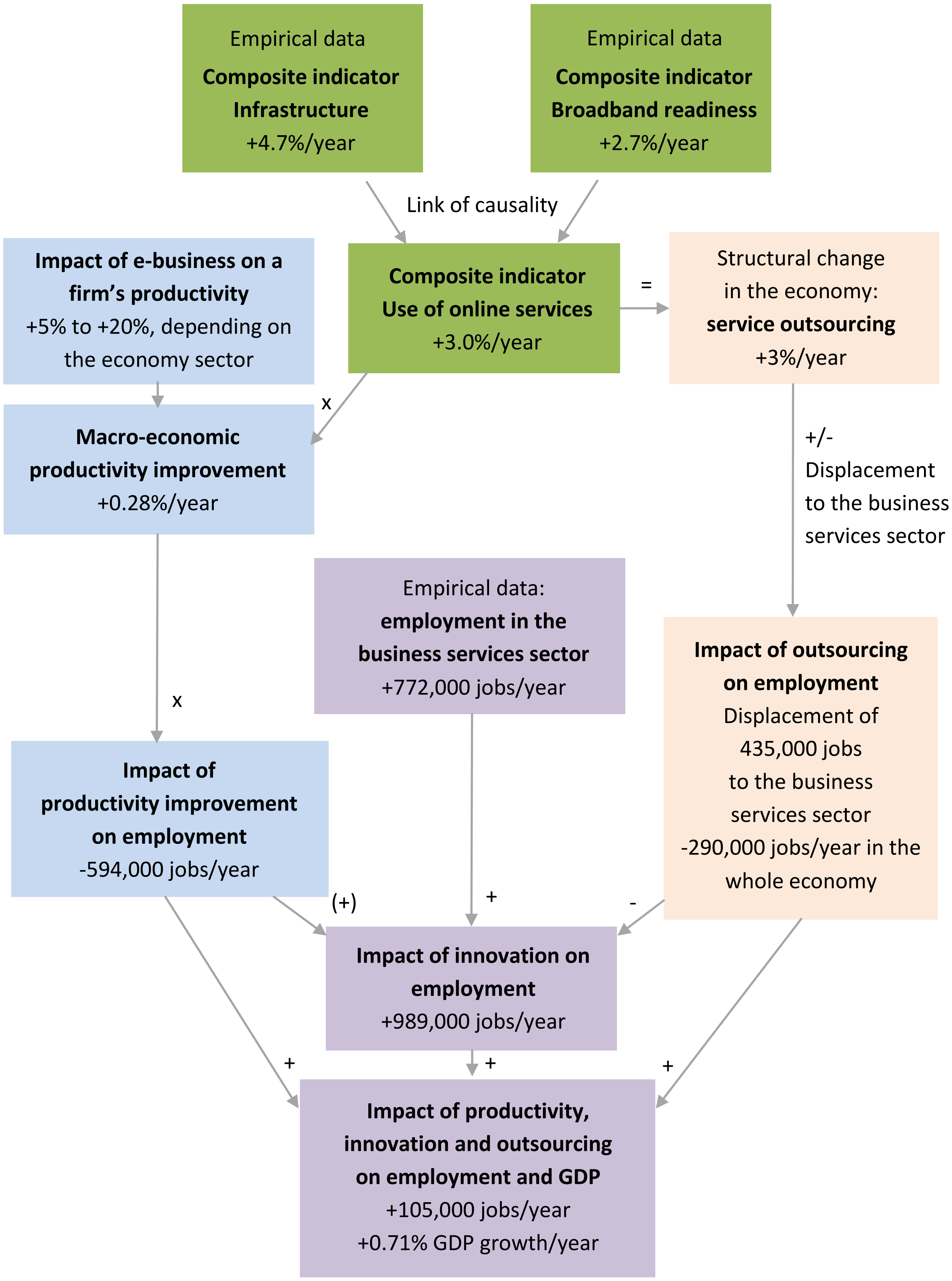
			Demand side aspects							Others	
		er main distribution frame (M		GDP per capita (€)		Fixed broadband penetratic		UMTS penetration (% pop)			Inter-modal c
2006		Data 2006	**Category 3**	Normalized	Data 2006	Normalized	Data 2006	Normalized	Data 4Q2006	**Category 4**	Normalized
EU (25 count	EU25										
EU (15 count	EU15										
Belgium	BE	10905.2632	35.38%	42.29%	29874.3527	60.85%	22.72%	2.99%	1.20%	58.02%	68.19%
Bulgaria	BG		8.21%	11.38%	8040	12.70%	4.74%	0.56%	0.22%	52.03%	67.19%
Czech Repub	CZ		15.47%	15.57%	11001.6014	28.42%	10.61%	2.42%	0.97%	57.40%	99.26%
Denmark	DK	4500	57.59%	57.32%	40492.2508	100.00%	37.34%	15.45%	6.20%	72.41%	76.32%
Germany	DE	10443.038	35.33%	39.60%	27976.4299	48.20%	18.00%	18.19%	7.30%	62.90%	39.05%
Estonia	EE	1030.53435	23.70%	13.75%	9712.15299	54.09%	20.20%	3.25%	1.30%	54.73%	91.00%
Ireland	IE	3290.5297	40.25%	59.17%	41799.6603	33.79%	12.62%	27.79%	11.15%	45.51%	58.16%
Greece	EL	5235.37803	15.45%	24.83%	17541.2361	11.83%	4.42%	9.69%	3.89%	19.55%	36.23%
Spain	ES	6015.21358	32.95%	31.84%	22493.7966	43.26%	16.15%	23.73%	9.52%	51.07%	54.51%
France	FR	4459.25926	39.28%	40.21%	28405.9737	57.02%	21.29%	20.60%	8.26%	59.14%	41.10%
Italy	IT	4983.18584	49.79%	35.64%	25174.4726	40.50%	15.12%	73.22%	29.37%	48.48%	39.52%
Cyprus	CY		16.96%	27.13%	19164.0219	23.56%	8.80%	0.20%	0.08%	10.50%	40.01%
Latvia	LV		13.13%	9.84%	6953.4523	26.14%	9.76%	3.40%	1.37%	53.62%	97.44%
Lithuania	LT	2642.52696	12.81%	9.95%	7030	28.15%	10.51%	0.33%	0.13%	51.14%	92.13%
Luxembourg	LU	6666.66667	63.14%	100.00%	70640	60.42%	22.56%	29.00%	11.63%	49.70%	44.91%
Hungary	HU	6107.27273	14.15%	12.51%	8839.09244	27.84%	10.40%	2.09%	0.84%	52.41%	72.83%
Malta	MT	18923.0769	15.50%	17.16%	12120.4837	27.49%	10.26%	1.87%	0.75%	60.32%	71.97%
Netherlands	NL	11927.5786	49.71%	45.81%	32359.8818	85.28%	31.84%	18.03%	7.23%	67.59%	71.80%
Austria	AT	5403.76851	41.59%	44.07%	31129.4191	48.03%	17.93%	32.66%	13.10%	65.90%	72.05%
Poland	PL	5039.05528	8.48%	10.01%	7067.91182	14.03%	5.24%	1.42%	0.57%	35.55%	54.91%
Portugal	PT	5558.77617	40.03%	20.84%	14720.1686	47.23%	17.63%	52.03%	20.87%	63.91%	67.27%
Romania	RO		9.08%	9.68%	6840	13.06%	4.88%	4.49%	1.80%	66.67%	100.00%
Slovenia	SI	2670.66667	23.64%	21.05%	14867.3764	37.44%	13.98%	12.44%	4.99%	39.29%	66.15%
Slovakia	SK		9.21%	11.55%	8157.67437	13.84%	5.17%	2.24%	0.90%	37.19%	85.60%
Finland	FI	872.666667	52.21%	45.31%	32006.8485	80.94%	30.22%	30.38%	12.19%	66.67%	47.81%
Sweden	SE	1290.57143	54.59%	48.08%	33967.2246	69.96%	26.12%	45.73%	18.34%	56.58%	71.74%
United Kingd	UK	10576.7857	67.89%	44.42%	31375.0874	59.24%	22.12%	100.00%	40.11%	59.25%	56.53%

									Use of online services	
									Online services through a	
		ompetition (in	Share of Local loop Unbun		Market share other than the		DSL coverage in rural areas (% pop)			Companies u
2006		Data 2006	Normalized	Data 2006	Normalized	Data 2006	Normalized	Data 2005	**Category 1**	e_igovrt_200
EU (25 count	EU25								42.25%	44.81%
EU (15 count	EU15								43.14%	44.98%
Belgium	BE	1.88235294	5.23%	0.56%	58.68%	52.81%	100.00%	100.00%	41.32%	36.62%
Bulgaria	BG	1.85459941	0.00%	0.00%	88.89%	80.00%			18.31%	22.90%
Czech Repub	CZ	2.73972603	2.49%	0.27%	70.46%	63.41%			46.87%	32.37%
Denmark	DK	2.10658358	50.90%	5.49%	62.42%	56.18%	100.00%	100.00%	55.16%	55.11%
Germany	DE	1.07800597	100.00%	10.78%	57.55%	51.80%	55.00%	55.00%	42.96%	37.13%
Estonia	EE	2.51192661	10.18%	1.10%	63.01%	56.71%			48.91%	54.43%
Ireland	IE	1.6053068	10.16%	1.10%	57.22%	51.50%	56.50%	56.50%	46.15%	56.49%
Greece	EL	1	1.33%	0.14%	40.65%	36.59%	0.00%	0.00%	44.54%	76.27%
Spain	ES	1.50465022	17.73%	1.91%	50.05%	45.04%	82.00%	82.00%	37.26%	38.04%
France	FR	1.134521	50.00%	5.39%	57.55%	51.80%	87.90%	87.90%	41.83%	51.26%
Italy	IT	1.09072165	73.34%	7.90%	36.48%	32.83%	44.60%	44.60%	40.37%	49.43%
Cyprus	CY	1.10448204	0.00%	0.00%	1.98%	1.79%	0.00%	0.00%	19.98%	8.25%
Latvia	LV	2.68965517	0.00%	0.00%	63.42%	57.08%			27.40%	20.64%
Lithuania	LT	2.54311649	0.35%	0.04%	57.50%	51.75%	54.60%	54.60%	38.27%	55.63%
Luxembourg	LU	1.23969768	25.51%	2.75%	28.40%	25.56%	100.00%	100.00%	36.39%	32.32%
Hungary	HU	2.010279	0.08%	0.01%	60.75%	54.67%	76.00%	76.00%	24.42%	27.68%
Malta	MT	1.98665243	0.00%	0.00%	70.29%	63.27%	99.00%	99.00%		
Netherlands	NL	1.98173785	38.36%	4.13%	61.21%	55.09%	99.00%	99.00%	46.06%	60.95%
Austria	AT	1.98887358	57.53%	6.20%	67.01%	60.31%	67.00%	67.00%	41.26%	53.73%
Poland	PL	1.51575931	0.00%	0.00%	35.39%	31.85%	51.90%	51.90%	35.63%	56.31%
Portugal	PT	1.85673352	49.52%	5.34%	59.85%	53.86%	79.00%	79.00%	35.71%	53.70%
Romania	RO	2.76026273	0.00%	0.00%	100.00%	90.00%			14.21%	12.97%
Slovenia	SI	1.82580435	13.30%	1.43%	50.71%	45.63%	27.00%	27.00%	47.16%	49.08%
Slovakia	SK	2.36289382	0.00%	0.00%	38.15%	34.33%	25.00%	25.00%	39.12%	44.59%
Finland	FI	1.3197194	93.00%	10.02%	47.87%	43.09%	78.00%	78.00%	60.00%	77.87%
Sweden	SE	1.9802779	19.01%	2.05%	69.57%	62.61%	66.00%	66.00%	61.14%	52.82%
United Kingd	UK	1.56028537	2.16%	0.23%	83.41%	75.07%	94.90%	94.90%	40.50%	37.65%

			Cronbach Alpha:		0.884					
		a website - all indicators are issued fro			eCommerce					Interconnect
		Companies u	Companies u	Companies providing onlin		% companies	% companies	Companies s	Companies purchasing ove	
2006		e_iass_2006	e_ibk_2006	e_webass_20	**Category 2**	e_ibuy1_200	e_isel1_2006	e_esell_2006	e_ebuy_2006	**Category 3**
EU (25 count	EU25	33.39%	74.09%	16.70%	20.29%	26.05%	11.54%	15.12%	28.43%	17.41%
EU (15 count	EU15	35.55%	74.42%	17.61%	21.71%	28.07%	12.22%	16.05%	30.51%	18.71%
Belgium	BE	32.35%	83.38%	12.92%	13.95%	13.12%	12.03%	14.77%	15.89%	25.74%
Bulgaria	BG	8.34%	39.93%	2.06%	2.53%	2.89%	2.05%	2.06%	3.14%	9.35%
Czech Repub	CZ	43.21%	86.66%	25.24%	11.51%	15.16%	5.77%	8.21%	16.90%	16.42%
Denmark	DK	46.34%	92.40%	26.78%	31.90%	30.24%	29.54%	33.93%	33.92%	39.33%
Germany	DE	47.90%	72.68%	14.12%	31.80%	45.65%	15.92%	18.09%	47.56%	21.65%
Estonia	EE	35.58%	90.34%	15.29%	14.93%	15.72%	13.02%	13.79%	17.19%	16.33%
Ireland	IE	30.80%	81.37%	15.95%	36.84%	51.30%	20.54%	22.72%	52.80%	21.81%
Greece	EL	22.01%	69.56%	10.34%	8.57%	9.65%	6.14%	7.34%	11.15%	18.77%
Spain	ES	23.17%	78.82%	9.01%	11.05%	13.57%	7.50%	8.40%	14.73%	11.66%
France	FR	29.60%	72.40%	14.07%	17.72%	18.05%	13.68%	18.45%	20.69%	25.33%
Italy	IT	27.39%	75.32%	9.35%	5.95%	8.92%	2.35%	2.81%	9.73%	3.09%
Cyprus	CY	17.83%	49.13%	4.70%	7.78%	9.63%	5.71%	6.03%	9.76%	13.92%
Latvia	LV	11.58%	72.58%	4.79%	2.17%	2.53%	1.74%	1.76%	2.66%	7.10%
Lithuania	LT	11.51%	82.80%	3.12%	15.31%	17.14%	13.34%	13.46%	17.31%	13.31%
Luxembourg	LU	31.07%	70.65%	11.54%	19.78%	27.96%	9.45%	11.45%	30.26%	17.99%
Hungary	HU	10.61%	53.93%	5.48%	9.15%	9.21%	8.02%	8.58%	10.79%	9.46%
Malta	MT									
Netherlands	NL	31.99%	73.68%	17.62%	26.46%	29.99%	20.79%	23.27%	31.78%	27.14%
Austria	AT	13.47%	85.65%	12.21%	24.86%	34.46%	13.07%	15.37%	36.53%	20.56%
Poland	PL	12.48%	66.45%	7.27%	11.02%	12.87%	6.27%	9.34%	15.60%	5.17%
Portugal	PT	18.93%	62.27%	7.96%	10.01%	13.32%	5.24%	7.06%	14.41%	11.30%
Romania	RO	11.31%	30.15%	2.40%	3.77%	5.02%	2.09%	2.52%	5.46%	10.18%
Slovenia	SI	32.06%	89.34%	18.16%	14.09%	17.03%	10.58%	11.18%	17.56%	19.64%
Slovakia	SK	20.97%	78.29%	12.64%	17.03%					20.46%
Finland	FI	40.98%	91.65%	29.52%	15.99%	18.54%	8.69%	13.61%	23.13%	23.56%
Sweden	SE	71.70%	88.84%	31.21%	32.78%	41.84%	20.98%	23.93%	44.36%	25.50%
United Kingd	UK	35.11%	68.53%	20.73%	35.31%	44.36%	15.84%	30.42%	50.63%	23.00%

		ted IT systems		Emerging internet technologies				
		Companies hav	Companies having IT systems		Telephone, vi	Web radios, \	Chat, newsgr	Have employ
2006		e_tele_2006	e_itlnke_2006	**Category 4**	i_iuph	i_iuweb	i_ichat	e_telebus
EU (25 count	EU25	21.29%	13.54%	12.30%	7.12%	11.76%	18.82%	11.52%
EU (15 count	EU15	22.54%	14.88%	12.42%	6.89%	12.07%	18.36%	12.36%
Belgium	BE	34.15%	17.33%	12.59%	7.88%	10.87%	17.87%	13.76%
Bulgaria	BG	16.04%	2.67%	10.61%	7.14%	10.55%	20.09%	4.66%
Czech Repub	CZ	22.57%	10.26%	10.49%	8.75%	6.47%	14.06%	12.69%
Denmark	DK	54.64%	24.01%	26.50%	13.11%	27.00%	31.17%	34.72%
Germany	DE	26.55%	16.75%	15.29%	10.43%	11.84%	25.71%	13.17%
Estonia	EE	23.75%	8.90%	22.19%	14.29%	16.53%	44.59%	13.35%
Ireland	IE	29.18%	14.44%	10.93%	5.75%	9.07%	8.49%	20.44%
Greece	EL	22.18%	15.36%	6.86%	1.83%	5.42%	9.19%	11.01%
Spain	ES	10.78%	12.54%	10.65%	6.32%	11.15%	18.49%	6.66%
France	FR	34.44%	16.22%	7.96%	4.86%	10.25%	8.54%	8.17%
Italy	IT	4.20%	1.98%	7.91%	3.31%	5.26%	20.67%	2.42%
Cyprus	CY	17.81%	10.04%	8.23%	4.58%	8.97%	8.61%	10.76%
Latvia	LV	9.06%	5.15%	13.68%	13.97%	17.00%	20.09%	3.68%
Lithuania	LT	17.57%	9.06%	14.37%	11.29%	16.89%	22.09%	7.20%
Luxembourg	LU	22.32%	13.66%	19.91%	16.34%	21.57%	30.56%	11.16%
Hungary	HU	13.53%	5.39%	11.80%	7.78%	12.11%	22.02%	5.31%
Malta	MT			9.42%	4.10%	9.88%	16.82%	6.89%
Netherlands	NL	36.31%	17.97%	18.45%	10.07%	27.91%	21.83%	14.01%
Austria	AT	23.85%	17.26%	12.12%	7.45%	6.72%	20.70%	13.62%
Poland	PL	5.61%	4.72%	11.05%	8.00%	9.81%	22.92%	3.46%
Portugal	PT	15.37%	7.24%	8.84%	5.54%	10.68%	11.36%	7.77%
Romania	RO	10.41%	9.95%	5.22%	2.46%	4.47%	9.13%	4.81%
Slovenia	SI	32.00%	7.27%	14.41%	4.40%	14.74%	21.44%	17.06%
Slovakia	SK	31.15%	9.77%	10.18%	6.96%	8.22%	17.16%	8.40%
Finland	FI	34.20%	12.93%	21.35%	14.22%	20.06%	26.16%	24.96%
Sweden	SE	42.19%	8.82%	22.16%	8.62%	28.47%	20.27%	31.27%
United Kingd	UK	35.13%	10.86%	14.88%	6.69%	15.20%	16.55%	21.10%

The impact of broadband on growth and productivity
Annex 3: Flow chart - simplified graphical description of the model



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The impact of broadband on growth and productivity
Annex 4: Set of equations - detailed mathematical description of the model

1. From broadband penetration to the use of online services

Broadband penetration is not the only factor having an impact on the adoption of online services. These factors have been classified in two categories:

- Infrastructure: coverage, existing network, penetration, competition, technology mix…
- Human factors: IT skills, access to a personal computer, IT professionals, innovation, strategic broadband connections

See the description of the composite indicators used in the study for more details.

The influence of these two categories of factors on the use of online services can be described as follows:

(1) $\Delta onlserv = \alpha \,.\, \Delta infrastructure + \beta \,.\, \Delta human$

With:

Δonlserv: the yearly growth of the composite indicator “use of online services” defined in the study

Δinfrastructure: the yearly growth of the composite indicator “infrastructure” defined in the study

Δhuman: the yearly growth of the composite indicator “IT skills and awareness” defined in the study

α: linear coefficient, $\alpha = 0.66$

β: linear coefficient, $\beta = 0.33$

See also a description of the methodology used to set α and β. These factors have been calculated under the following hypothesis:

- There is no other factor having an impact on the use of services
- There is no cross-effect between infrastructure and human factors, or feed-back effect from the services to the infrastructure or human factors
- There is a linear relation of the 2nd degree between services, infrastructure and human skills.

Quick calculation

For the quick calculation tool, the number of input variables has been reduced to the minimum: instead of the two composite indicators for infrastructure and broadband readiness, the only input factor is the broadband penetration. The results of the quick calculation depend only on this single parameter, and should be considered a very schematic or simplistic view of the reality.

(1’) $\Delta onlserv = a \,.\, \Delta penetration$

With:

a: linear coefficient, $a = 0.279$

Δpenetration: broadband penetration in households

2. Micro-economic impact of e-business use on productivity

E-business does not have the same impact on firms’ productivity in all sectors of the economy. To simplify, we only distinguish between the primary/secondary sector (agriculture, mining, manufacturing, construction) and the service sector.

(2) $Impprod(all) = (impprod(manuf) \,.\, manuf/all + impprod(services) \,.\, services/all)$

With:

Impprod: a function of an industry sector, giving the labor productivity improvement achieved by a firm adopting e-business in the considered economy sector. The values used in the study, on basis of precedent literature, are the following:

Impprod(manuf) = 5%

Impprod(services) = 10%

Impprod(K) = 20% sector NACE K: real estate and business services

Manuf/all and services/all: share of each considered sector in the total, in number of employees (source: LFS)

3. Impact of productivity on employment

E-business is not adopted simultaneously by all companies. In particular, small companies tend to need more time before they adopt e-business solutions. As a consequence, the annual productivity improvement due to broadband depends on the annual adoption rate of online services.

(3) Δproductivity(x) = Δonlserv . impprod(x)

At constant output, labor productivity improvements leads to a direct employment reduction:

(4) Δempl-prod(x) = - Δproductivity(x) . employment(x)

With:

Δproductivity: the yearly labor productivity growth due to the adoption of broadband- related e-business technologies

Δempl-prod: the yearly impact of labor productivity improvement on the employment in the considered sector, considered at constant output.

Employment: source: LFS

4. Impact of outsourcing on employment

Little data is available concerning the adoption of outsourcing. Outsourcing considered here is not limited to IT outsourcing, but concerns all business services used by a company. These business services may be internal (in-house accountancy, IT department, etc…) or external (outsourcing).

Adoption rate of outsourcing is considered equal to the adoption of e-business:

(5) Δoutsourcing = Δonlserv

Outsourced jobs are directly subtracted from the considered economy sector:

(6) Δempl-outsrc(x) = - Δoutsourcing . θ . employment (x)

Outsourced jobs are transferred to the economy sector K. Only a part of the jobs which are lost in other sectors are created in the sector K:

(7) Δempl-outsrc(K) = Γ . Δempl-outsrc(all)

With:

Δoutsourcing: the yearly adoption rate of outsourced business services

Δempl-outsrc: the yearly impact of outsourcing on the employment in the considered sector.

θ: Share of business services (internal + external) in a company. The value used in the study is the following (Source: Abramovsky and Griffith, 2005, "Outsourcing and off-shoring of business services: how important is ICT?"): θ = 13%

Γ: Employment transfer rate from the outsourcer to the business services provider. Γ = 60%

5. Impact of innovation on employment in the business services sector

The apparent employment growth in the business services sector does not take into account the savings induced by productivity improvements in this sector. According to the equation (4) above, the adoption of e-business solutions in the business services sector has a negative impact on employment. The real employment creation is the sum of the apparent job creation and the employment reduction due to productivity improvement:

(8) Δemployment(K) = Δnet-employment(K) + | Δempl-prod(K) |

Job creation in the business services sector is also due to two effects:

- Transfer of employment from other sectors to this sector, due to outsourcing
- Employment creation due to innovative activities

The following equation is used to quantify the job creation due to innovative activities:

(9) Δemployment(K) = Δempl-outsrc(K) + Δempl-inno(K)

With:

Δnet-employment(K): net job creation per year in the sector K. The value used in the study is the geometric growth of employment in the sector K between 2000 and 2006 (source: LFS, Eurostat)

Δempl-inno(K): job creation per year that cannot be explained by displacement effects (outsourcing), and credited to innovative activities.

6. Impact of innovation on employment in all sectors

The rate:

(10) ρ = created jobs / loss jobs

is primarily calculated for the business services sector and then used for the calculation of the effect of innovation in the other economic sectors.

Loss jobs in the business services sector are considered due to two effects:

- Productivity improvements in the sector K: Δempl-prod(K)
- Employment reduction due to outsourcing: transfer of jobs from all sectors of the economy to the sector K

(11) Δempl-outsrc = Δempl-outsrc(K) - | Δempl-outsrc(all) |

In the business services sector:

(10') ρ = Δempl-inno(K) / | Δempl-prod(K) + Δempl-outsrc |

In the rest of the economy, innovation is considered to occur in the activities where productivity improvements take place. For this reason, the innovative activities are calculated on basis of the productivity effect.

(12) Δempl-inno(x) = ρ . | Δempl-prod(x) |

The general impact of broadband on employment is expressed by the following:

(13) Δemployment = Δempl-outsrc + Δempl-inno(K) + Δempl-inno(all - K) + Δempl-prod(K) + Δempl-prod(all - K)

With:

ρ: a rate defined by the equation (10). Its value in the study, calculated with the equation (10'), is equal to 112%

Δempl-outsrc: yearly effect of outsourcing on employment, on the whole economy. This effect is negative.

Δempl-inno(x): job creation per year accredited to broadband-related innovation in the considered sector x, by similarity to the business services sector.

7. Impact of outsourcing on GDP

The impact of outsourcing is calculated on basis of the labor productivity (value added created by an employee in the considered sector). The labor productivity varies with the economy sector considered, business services being one of the most productive sectors.

Productivity improvements were considered at constant output: according to this framework, they have no impact on GDP growth. It is to be considered, however, that the effects of innovation on the GDP would not have been reached without the workforce availability due to the effects of both productivity improvement and outsourcing on employment.

The impact of outsourcing is calculated by subtraction of the value added represented by the employment reduction in all sectors, to the value added represented by the employment creation in the service sector:

(14) ΔGDP-outsrc = LP(K) . Δempl-outsrc(K) – LP(all) . | Δempl-outsrc(all) |

With:

ΔGDP-outsrc: yearly effect of outsourcing on GDP, on the whole economy. This effect is positive.

LP(x): Labor productivity in the considered sector x. (Source: National accounts - Eurostat) The following values were used in the study:

LP(K) = 105 k€ / employee

LP(all) = 55 k€ / employee

Impact of innovation on GDP

The impact of innovation on GDP is simply calculated on basis of the job creation due to innovation in the considered economy sector:

(15) ΔGDP-inno = LP(K) . Δempl-inno(K) + LP(all) . Δempl-inno(all - K)

The general impact of broadband on GDP is expressed by the following:

(16) ΔGDP = ΔGDP-outsrc + ΔGDP-inno

With

ΔGDP-inno: yearly effect of broadband-related innovation on GDP, on the whole economy.

8. Growth and employment allocation to each of the country groups

The benefits of broadband for employment and GDP is allocated to each of the country groups, according to their employment volume (respectively: GDP) and their use of online services.

(17) $\Delta GDP(CGx) = \Delta GDP(EU27) . GDP(CGx) . onlserv(CGx) / (\Sigma_{CG}\ GDP . onlserv)$

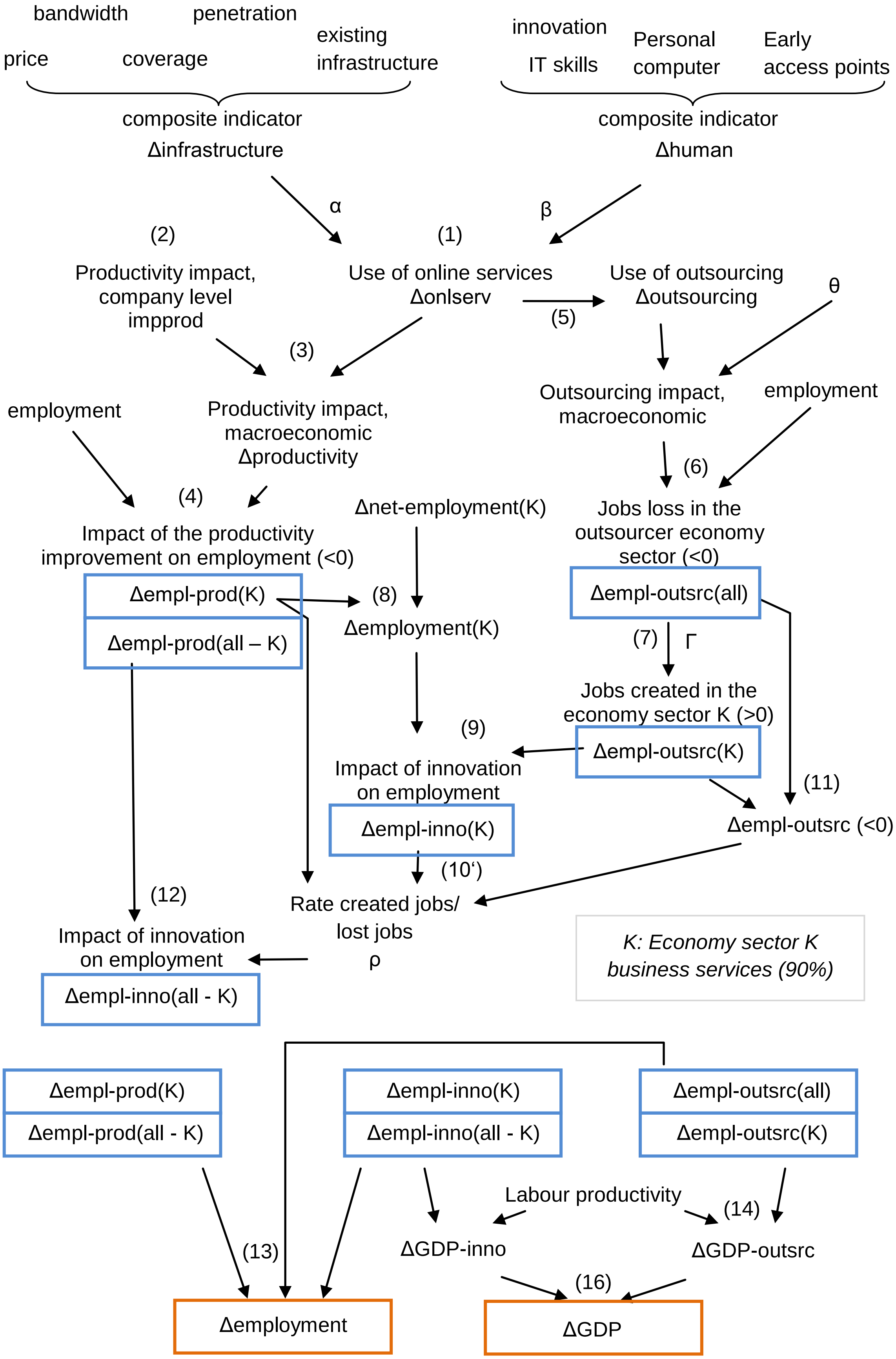
(18) $\Delta employment(CGx) = \Delta employment\ (EU27) . employment\ (CGx) . onlserv(CGx) / (\Sigma_{CG}\ employment . onlserv)$

With:

ΔGDP(CGx) and Δemployment(CGx): broadband related growth of the GDP and employment in the country group x

Σ_{CG} GDP . onlserv : sum of the product (GDP . onlserv) in all four country groups.

9. Graphical representation of the calculation framework:



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The impact of broadband on growth and productivity
Annex 5: Quick calculation tool

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.

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. Are the positive impacts of the internet on the economy larger than the negative ones? The issues at stake are crucial to sustaining a high level of employment and economic activity in Europe.

The study "the impact of broadband on growth and productivity" on behalf of the European Commission, DG Information and Media, aims to quantify the impacts of broadband internet on the economy. Empirical analysis of the development of broadband in the 27 member states as well as micro-economic data permitted to quantify both negative and positive impacts of broadband. Both are considerable, and concern more than 1 million workers each year in Europe. A sustained innovation activity, though, yields a positive net impact on the employment level in Europe.

This "quick calculation tool" allows to use the framework specifically developed for the study, to estimate the impact of an increase in the broadband penetration on the employment level and the GDP. It has two main input fields:

- Increase in broadband penetration in households per year: the broadband penetration in Europe increased by slightly more than 10% per year on average in Europe over the period 2003-2006. This tool can be used to test values around the reference situation.

- Economic data: the model requires some economic characteristics of the considered economic area. By default, these values are set on Europe in 2006. In this quick calculation tool, some internal parameters of the model are also set on the European average values. This tool should not be used to evaluate the impact of broadband in national or local economies, the economic structure of which are very different from the European average.

An important result of the study is the complex influence of many factors on the economic impact of broadband, including factors concerning the readiness of the population in using broadband technologies. No less than 35 indicators were used to analyze the development of broadband and the knowledge society. The quick calculation tool is limited to one indicator: the broadband penetration. As a consequence, the results provided by this tool are less precise than the results from the complete framework.

Input fields:

Increase in broadband penetration:	10.5	%/ year

Economic data		
(Source: Labor Force Survey)		
Employment, all economic sectors	213957	000s jobs
Employment, service sector	141940	000s jobs
Employment, NACE sector K	19906	000s jobs
Labor productivity, all economy average	55	k€/employee
Labor productivity, business services sector	105	k€/employee
GDP, all economic sectors	11583	bn€

Results of the calculation:

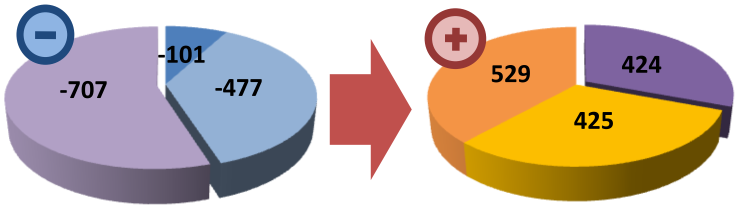
All results on this page are updated automatically, and should not be manually modified.

Increase in the use of online services:	2.93	%/ year

Impact of broadband on employment growth

Jobs lost in all economic sectors (000s jobs/year)

Jobs created in all economic sectors (000s jobs/year)



-1,285,000 jobs/year

+1,378,000 jobs/year

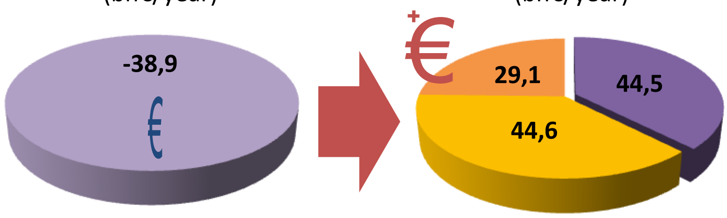
- Productivity improvement in the business services sector
- Productivity improvement in other economic sectors
- Displacement (outsourcing) from other sectors of the economy
- Displacement (outsourcing) to the business services sector
- New activity in the business services sector
- New activity in other economic sectors

93,000 jobs/year — Broadband-related employment growth in all sectors of the economy

Impact of broadband on GDP growth

Activity lost in traditional sectors of the economy (bn€/year)

Activity growth in all economic sectors (bn€/year)



-38.9 bn€/year

+118.2 bn€/year

- 0 Productivity improvement in the business services sector
- 0 Productivity improvement in other economic sectors
- Displacement (outsourcing) from other sectors of the economy
- Displacement (outsourcing) to the business services sector
- New activity in the business services sector
- New activity in other economic sectors

+79.4 bn€/year — Broadband-related GDP growth in all sectors of the economy

Broadband-related GDP-Growth:	0.69	%/ year

The impact of broadband on growth and productivity
Annex 5: Quick calculation tool (2) - Detailed calculation

This page contains the detailed calculation, the results of which are presented in the first sheet of this document. The calculation methodology is also succintly presented here; for more information see the Final Report of the study and the annex: Methodology - Equations.

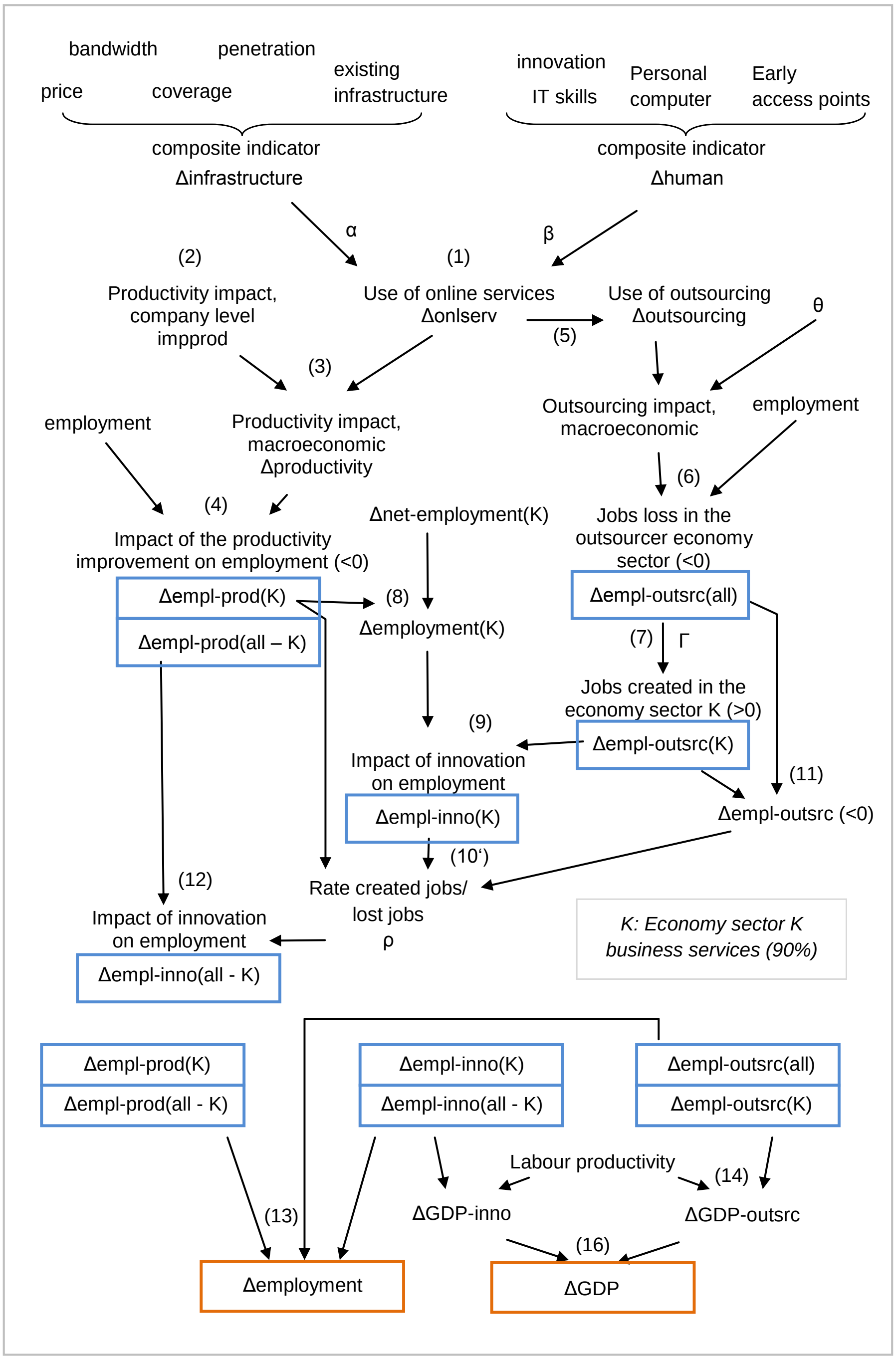


Figure 1 - Grafical summary from the annex: Methodology - Equations

Notes:

- in the quick calculation, the equation: (1) Δonlserv = α . Δinfrastructure + β . Δhuman
  is replaced with the simplified equation: (1') Δonlserv = a . Δpenetration
- the rate ρ, which is an intermediary result in the calculation framework (equation 10), is here a function of Δonlserv.
  This function takes into account the "prime" effect and the penalty effect of a slower or quicker broadband development on innovation, as described in the main report.

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	Title	Value	Unit	Variable
Broadband:	Broadband penetration in households, progress	10.5%	% of households	Δpenetration
	Services adoption / penetration progress	0.279	Linear coefficient	a
	Adoption rate of online services	+2.93%	% of companies	Δonlserv
Outsourcing:	Employment - "outsourcer" economic sectors	185,569	1000s jobs	employment(all)
	Business services/ total output	13%	(%)	θ
	Progression rate of outsourcing	+2.93%	(%/year)	Δoutsourcing
	Displaced jobs	-707	1000s jobs/year	Δempl-outsrc(all)
	Transfer rate	60%	(%)	Γ
	Jobs created in the service sector	424	1000s jobs/year	Δempl-outsrc(K)
	Lost jobs, whole economy	-283	1000s jobs/year	Δempl-outsrc
Business servi	Business services	17,219	1000s jobs	employment(K)
	Productivity effect	+20%	(%)	Impprod(K)
	Adoption rate	+2.93%	(%/year)	Δonlserv(K)
	Lost jobs per year	-101	1000s jobs/year	Δempl-prod(K)
	Total job destruction (productivity+outsourcing)	-384	1000s jobs/year	Δempl-prod(K) + | Δempl-outsrc |
	Innovation/jobs subtracted	111%	(%)	ρ
	Innovation effect	425	1000s jobs/year	Δempl-inno(K)
	Total job creation business services, per year	849	1000s jobs/year	Δemployment(K)
	Net job creation per year	748	1000s jobs/year	Δnet-employment(K)
Productivity ef	Whole economy EU27 - sector K	194,051	1000s jobs	employment(all-K)
	Productivity effect, manufacturing	+0.13%	(%)	Impprod(manuf)
	Productivity effect, services	+0.31%	(%)	Impprod(services)
	Employment, services without NACE k	122,034	1000s jobs	services/all
	Lost jobs, manufacturing	-95	1000s jobs/year	Δempl-prod(manufacturing)
	Lost jobs, services without NACE k	-383	1000s jobs/year	Δempl-prod(services - K)
	Lost jobs per year, total	-477	1000s jobs/year	Δempl-prod(all-K)
	Innovation effect, all economy without sector K	529	1000s jobs/year	Δempl-inno(all-K)
	Net job creation per year - without business service	52	1000s jobs/year	Δempl-inno(all-K)+Δempl-prod(all-K)
Total - employ	Net job creation per year - total	93	1000s jobs/year	Δemployment
	In percent of whole economy	+0.04%	(%/year)	Δemployment/employment
Value added:	Labor productivity, all economy	55	1000€/year/pers	LP(all)
	Labor productivity, business services	105	1000€/year/pers	LP(K)
	Displacement value added, all economy	-38.9	bn€/year	ΔGDP-outsrc(all)
	Displacement value added, business services	44.5	bn€/year	ΔGDP-outsrc(K)
	Total displacement value added	5.7	bn€/year	ΔGDP-outsrc
	Innovation value added, all economy	29.1	bn€/year	ΔGDP-inno(all-K)
	Innovation value added, business services	44.6	bn€/year	ΔGDP-inno(K)
	Total Innovation value added	73.7	bn€/year	ΔGDP-inno
	Total value added	79.4	bn€/year	ΔGDP
	GDP EU27, 2006	11,583	bn€	GDP
	BB-value added/all economy	+0.69%	(%/year)	ΔGDP/GDP

The impact of broadband on growth and productivity
Annex 6: Step-by-step detailed reading of the Quick Calculation Tool (QCT)

This document explains step by step the calculation of the impact of broadband on growth and productivity, the way it is made in the model presented in the final report and the quick calculation tool.

The quick calculation tool is a print-friendly calculation table divided into two sheets: the “Simple” sheet and the “Expert” sheet. References to the calculation table will be made as follows: “S-18” refers to line 18 of the “Simple” sheet, while “E-106” refers to line 106 of the “Expert” sheet.

The figures given in the following explanations are based on a 10.5% yearly growth of the broadband penetration (to be entered in S-18).

a. From broadband penetration to the use of online services

E-67: As explained in the introduction of Section 2 in the main report, and with more details in Section 2.2, the broadband penetration in households is far from being the only factor driving the adoption of online services in companies.

In the main report, the adoption of online services in companies depends on two complex factors: the development of the broadband infrastructure and the readiness of the people to use broadband technologies. These factors are quantified by using a total of 20 indicators (see Sections 2.1.1, 2.1.2 and 2.2.2 in the main report). This methodology is strongly based on empirical data, and was confirmed by the results from the two regional case studies (see Section 3 in the main report).

This methodology, however, is much too complicated for the quick calculation tool, where the 20 indicators used as inputs in the model shall be reduced to one: the broadband penetration in households. The causal link between the broadband penetration and the adoption of broadband technologies in companies is quite indirect, however, one can observe that these two statistics were relatively good correlated over the period 2003-2006 in the 27 European Member States.

The quick calculation tool uses a simplified calculation framework, where the use of online services in companies is simply proportional to the broadband penetration. The proportionality ratio (a) was found equal to 0.279 (see E-67).

E-68: The adoption of online services in companies is the product of the broadband penetration and the factor a. It is equal to 2,93% per year.

b. Outsourcing

Make sure that you understand the difference between outsourcing and off-shoring before reading the following text (see Sections 4.4.1 and 4.4.2 “What about off-shoring” in the main report).

E-69: Companies in most economy sectors may entrust parts of their in-house business services, such as accounting or procurement, to third companies, most of the time in the same country. We excluded from the “outsourcers” some particular kinds of services such as services to households. Excluded sectors represent in Europe 20% of the service sector (according to the employment statistics).

There are 185,569,000 jobs in the “outsourcer” economy sectors. This figure is calculated on the basis of the input values in S-23 and S-24.

E-70: According to the report from Abramovsky and Griffith based on empirical data in the UK (entry [1] in the Bibliography, Section 8 in the main report), on average 13% of the companies’ output are business services, including both in-house and outsourced services. The UK values are considered valid for Europe: the broadband-related displacement of activities to the business services sector concerns only 13% of the jobs in the “outsourcer” economy sectors. (parameter θ in E-70). See also Section 4.4.2 (“Displacement effect”) in the main report.

E-71: The progression of outsourcing (E-78) is considered equal to the progression of the use of online services (E-68). See also Section 4.4.2 (“How fast is the displacement occurring?”) in the main report.

E-72: Each year, 770,000 jobs are displaced to the business services sector. This displacement would not occur without broadband (see section 4.4 in the main report). The number of jobs displaced each year from all sectors of the economy to the business services sector (E-72) is the product of the total employment in the concerned sectors (E-69), the parameter θ (E-70) and the progression rate of outsourcing (E-78).

E-73: This displacement of jobs and economic activity implies an optimization of the processes. Only 60% of the employment volume is actually transferred to the business services sector. The remaining 40% are lost. See also Section 4.4.2 (“Impact of displacement”) in the main report.

E-74: 424,000 jobs are created in the business services sector,
E-75: while 283,000 jobs are lost due to process optimization.

c. Productivity improvement and innovation in the business services sector

We now focus on the business services sector, in which the impact of broadband is much easier to analyze, as we consider that all growth of activity in the business services sector is directly or indirectly related to broadband (see also Section 5.2 in the main report).

E-76: Employment statistics are generally available for the NACE sector K (Real estate, renting and business activities). Business activities represent 86.5% of the employment in the NACE sector K (European average, 2004), the rest being real estate and renting.

The business services sector represents 17,219,000 jobs (E-76) in the base calculation year. This value is calculated on the basis of the input value in S-25.

E-77: The impact of e-business on productivity has been evaluated equal to 20% in the business services sector (see Section 4.3.2 in the main report). Considering an adoption rate of broadband services of 2.93% per year (E-68), this corresponds to an increase in productivity of 0.58% per year in the business services sector (see Section 4.3.3 in the main report). See also the definition of the productivity used in the report, in the introduction to the Section 4 in the main report.

E-78: This cell is a copy of the cell E-68.

E-79: Productivity improvements in the business services sector yields a loss of jobs of 101,000 jobs per year (See section 5.2 in the main report). This is the product of the number of employees in the business services sector and the yearly productivity improvement in this sector.

E-80: When taking into account both jobs losses due to outsourcing (E-75) and productivity improvement (E-79), the total number of jobs losses due to process optimization in the business services sector is 384,000 jobs per year (see also Section 5.2 in the main report).

E-81: In the main report (deductive calculation), the net employment growth in the business service sector over the last few years can be derived from the available employment statistics. All employment creation which is not due to a displacement of activity from other economic sectors is purely “new” and considered due to innovation. It is possible to calculate the ratio of jobs created/ jobs lost in the business services sector. This ratio (named ρ) is a **result** of the deductive calculation, where it is equal to 112% (see also Section 5.2 in the main report).

In the quick calculation tool and the scenarios (Section 6.2 in the main report), we use the results of the deductive calculation for a **prospective calculation** where the ratio ρ is not a result but a given parameter. This parameter represents the success of innovation. It depends on the adoption of broadband services (Δonlserv, see E-68). The function ρ = f(Δonlserv) is explained in Section 6.2.2 in the main report.

E-82: 410,000 jobs per year are created due to innovative activities in the business services sector. This success would not have been possible without broadband (see Sections 4.4 and 5.2 in the main report). This is the product of the parameter ρ and the number of jobs lost (E-80).

E-83: 834,000 jobs per year are created in the business services sector, when considering the innovation effect (E-82) and the displacement effect (E-74).

E-84: The net growth measured by the employment statistics in the business services sector is only 733,000 jobs per year, because of the loss of jobs due to productivity improvements (E-79).

d. The effects of productivity improvement and innovation on the rest of the economy

E-85: We consider the total employment in the whole economy (S-23), less the business services sector (E-76).

E-86: The productivity improvement at the company level in the manufacturing sector has been evaluated equal to 5% in the case of a complete adoption of online services (see also Section 4.3.2 in the main report). This value, multiplied by the adoption rate of online services (E-68) and by a corrective factor (taking into account a slower adoption in the manufacturing sector than the average in the economy), yields a productivity improvement in the manufacturing sector of 0.13% per year.

E-87: In the same way in the services sector: the product of the productivity improvement for a complete adoption (10%) with the adoption rate of online services and a corrective factor yields a macro-economic productivity improvement in the services sector 0f 0.31% per year (see also Section 4.3.2 in the main report).

E-88: The productivity improvement in the services sector applies to 124,721,000 jobs.

E-89: The same way as in the business services sector (E-79), productivity improvement in the manufacturing sector causes a loss of 95,000 jobs per year (see also Sections 5.2 and 5.3 in the main report).

E-90: The same way, 391,000 jobs per year are lost in in-house business services in the services sector, due to productivity improvements.

E-91: 486,000 jobs per year are lost due to productivity improvements in the manufacturing and the services sector, in in-house business services. This is the sum of the two partial results in E-89 and E-90.

E-92: 519,000 jobs per year are created in activities similar to the business services sector, produced in enterprises from other sectors. More jobs are created through diffuse broadband-related service innovation in in-house business services, in enterprises from all economic sectors, than in the business services sector.

This is the product of the ratio ρ (E-81) with the number of jobs lost due to productivity improvements in these activities (E-91). See also Section 5.3 in the main report.

E-93: The difference between jobs lost and jobs created in the economy sectors others than business services is equal to 33,000 jobs per year.

E-94: The net number of jobs created in the whole economy, including the business services sector, is equal to 59,000 jobs per year. This accounts for all broadband-related effects.

E-95: This represents a growth of 0.03% per year of the employment volume in Europe. Noticeably, this value is quite small.

e. The impact of broadband on the gross value added

E-96: The labor productivity in the whole economy is equal to the gross value added divided by the total number of employees in the economy (national accounts), and should be entered in S-27 (see also the introduction to Section 4 in the main report for a definition of the productivity as used in this model).

E-97: The labor productivity in the business services sector is equal to the gross value added in the NACE sector K divided by the number of employees in this sector (national accounts), and should be entered in S-28.

E-98: The loss of 707,000 jobs in the whole economy due to the displacement effect (E-72) results, on the one hand side, in a reduction of the gross value added of €38.9bn per year. This is the product of the number of jobs lost and the labor productivity (E-96) in the whole economy. This loss will be immediately compensated on the second hand side by the displacement of this activity to the business services sector (see also Section 5.4 in the main report).

E-99: The creation of 424,000 jobs in the business services sector due to the displacement effect (E-74) results in a €44.5bn growth per year in the gross value added.

E-100: As a result, the net impact of this displacement effect on the economy is very limited (€5.7bn/year).

E-101: The creation of 510,000 jobs in broadband-related innovative activities in the whole economy (E-92) yields a growth in the gross value added of €28.0bn/year. This growth is not due to a displacement effect: it is a net growth. It would not have been possible without a better allocation of the competences in the business services activities (see Sections 5.3 and 5.4 in the main report).

E-102: Due to a higher productivity in the business services sector than in the rest of the economy (see E-96 and E-97), the creation of 410,000 jobs in innovative activities in the business services sector yields a growth in the gross value added of €43.0bn/year.

E-103: Broadband-related innovative activities yield a growth of the gross value added of €71.1bn/year. Notably, the most important direct contribution of broadband to the European economy is not an improvement in the productivity or the outsourcing effect, but innovation (mostly process innovation and service innovation). This innovation would not have been possible without a better allocation of the competences, which is an indirect effect of productivity improvements and outsourcing (see Section 5.4 in the main report).

E-104: When considering both the innovation effect and the displacement effect, the broadband-related growth in the gross value added is equal to €76.7bn/year.

E-105: A rigorous methodology would be to compare this value to the European gross value added (GVA). However, the reference indicator usually used to qualify the volume and the growth of an economy is the GDP. The difference between GDP and GVA is a different accounting of taxes, which is not considered here. The broadband-related growth in the value added (E-104) is directly compared to the European GDP.

E-106: A growth of €76.7bn/year represents a 0.66% growth of the European gross production.

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The impact of broadband on growth and productivity

Annex 7: Construction of the infrastructure model and the related development scenario

This annex presents the methodology used to get the results presented in the Section 6.1. of the main report: *Broadband coverage and penetration: development of the infrastructure*. This model was developed by WIK (www.wik.org) for MICUS, specifically for the study "The impact of broadband on growth and productivity".

The infrastructure model takes into account the broadband access technologies described in Section 1 of the main report:

- Fixed-link
  - xDSL: ADSL, ADSL2+, VDSL, SDSL
  - Cable modem
  - FTTB/H
  - „Other": Satellite, Powerline
- Fixed Wireless Access (FWA): WLL, WiMax (802.16, …)
- Mobile
  - UMTS; HSDPA/HSUPA; Long Term Evolution (LTE)
  - „4 G" (not further specified)

Inputs to the model were specified at the country level for each of the EU27 member states. The results of the development scenarios were aggregated at the level of the country groups (see section 2.2.1 of the main report) and the EU27.

Step 1: Estimate the broadband coverage in 2015 for each country and each technology

The specific coverage status in 2015 were estimated for each country and for each of the technologies, considering the following information sources:

- Characteristics of the current broadband, PSTN and mobile telecommunications infrastructure,
- Migration/investment plans of the telecommunications incumbents and competitors,
- Specific governmental objectives/programs relating to broadband,
- Demographic characteristics in urban/suburban and rural areas,

Available information, in particular press releases, analyst presentations and annual reports of the main incumbent and competitors telecommunications providers were analyzed in details for the following 17 countries: Austria, Belgium, Bulgaria, Cyprus, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Netherlands, Portugal, Slovenia, Spain, Sweden, UK. This analysis was completed in more than 10 member states with interviews of national experts in the broadband telecommunications sector. Additional information was collected concerning the remaining 12 members states, though at a lower level of details.

On the basis of this review of the available information, assumptions on the broadband coverage in 2015 were made in each country and for each considered technology. In the case that no detailed information was available in a country, assumptions on broadband coverage in 2015 were made by comparison with other countries in the same group of countries (see the main report, section 2.2.1).

	Countries with less developed broadband	Quickly developing countries	Large industries	Advanced knowledge societies
3G/4G	50%	60%	75%	75%
FTTX	3%	10%	15%	20%
ADSL	80%	90%	100%	100%
VDSL	5%	10%	40%	40%
FWA	30%	20%	10%	5%

Table 1 – Assumptions for broadband coverage (in % of population) in 2015

The aforementioned values may differ from the values in the model at the country level, in the case that detailed information are available for the considered countries. Examples are Malta (ADSL), France (FTTB/H), Portugal (ADSL) and Romania (ADSL).

Step 2: Estimate the broadband penetration in 2015

On the basis of the information review described in step 1, assumptions were made in the following order for each European member state:

- Broadband penetration in 2015, in % of households (including fixed link broadband, fixed wireless broadband and mobile)
- Percentage of households having no fixed link connection (mobile only) in 2015, on the basis of today's mobile only statistics
- Respective share of the fixed broadband market for ADSL, VDSL, Cable Modem, FTTB/H and Fixed Wireless technologies in 2015
- Percentage of the population using 3G/4G broadband services on their mobile device (this percentage is based on the estimated number of users, not the number of SIM cards: it cannot exceed 100%).

The following table presents these assumptions aggregated at the country group level:

	Countries with less developed broadband	Quickly developing countries	Large industries	Advanced knowledge societies
Total broadband penetration in households	65%	80%	95%	95%
Share of Mobile only households	19%	25%	18%	12%
Market share of Fixed Wireless technologies	15%	10%	3%	2%
3G/4G Users as % of the population	20%	30%	50%	60%

Table 2 - Assumptions for broadband penetration in 2015

These assumptions allow to calculate the number of subscribers for each technology and in each country until 2015.

Step 3: Estimate trajectories regarding coverage and penetration over the period 2006 -

2015

On the basis of the development strategies of incumbents and competitors telecommunications service providers reviewed as described in step 1, the following assumptions were made:

a. Assumptions on the increase in broadband **coverage** for each technology are primarily based at the country level on the development plans of the telecommunication services providers. These trajectories were completed by assuming a constant compound annual growth rate (CAGR) between the points in time where coverage objectives are known.

b. The increase in broadband **penetration**:

- is assumed to follow and S-trajectory for DSL technologies (ADSL, VDSL)
- is assumed to have a constant compound annual growth rate for other technologies, unless penetration objectives from the telecommunications services providers are known at the country level.

These assumptions allow to calculate the coverage and the number of subscribers for each technology, for each year over the period 2006-2015.

Step 4: Evaluate the annual market volumes over the period 2006 - 2015

a. Price of a standard ADSL subscription in 2006

Starting point for the calculation of the market volume is the monthly rental price for basic ADSL access of the incumbent operator in each country in 2006 (standard offer of the incumbent).

This price does not include:

- one-off charges (e.g. installation costs),
- hardware costs (e.g. terminal equipment charges), and
- basic subscription for voice access.

Country	Monthly price 2006	Country	Monthly price 2006
Austria	52.57 €	Italy	19.95 €
Belgium	31.55 €	Lithuania	14.18 €
Bulgaria	15.78 €	Luxembourg	26.00 €
Cyprus	25.63 €	Latvia	12.87 €
Czech Republic	14.44 €	Malta	16.49 €
Germany	34.95 €	Netherlands	20.00 €
Denmark	34.77 €	Poland	44.38 €
Estonia	16.55 €	Portugal	24.90 €
Greece	35.58 €	Romania	15.00 €
Spain	38.10 €	Sweden	29.84 €
Finland	23.90 €	Slovenia	26.00 €
France	24.90 €	Slovakia	28.16 €
Hungary	19.22 €	U.K.	36.27 €
Ireland	24.99 €		

Table 3 - Monthly fee for a standard DSL access from the incumbent service provider (2006)
Source : Our research

b. Standard price of the other fixed broadband access technologies

The standard price of the other access technologies is calculated on the basis of the standard price for DSL technologies and a technology-specific factor (see Table 4). The evaluation of this factor takes into account the prices of each technologies across Europe in 2006, as compared to DSL technologies.

Technology	Price factor (1 = DSL technologies)
Cable modem	1
FTTB/H	2.2
VDSL	1.8
FWA	1.5

Table 4 - Price factors for each broadband technology, in comparison to DSL prices

These assumptions, combined with the results of the precedent steps of the model construction, allow to calculate the total fixed broadband market volume in 2006.

c. Price deviation over the period 2007-2015

A price decrease of 2% per year is assumed over the period 2007-2015. This assumption is based on the evolution of the prices for basic telecommunications service over the last few years. Due to a switch of the market towards faster technologies (in particular FTTB/H), the average revenue per user (ARPU) on the broadband market should increase despite a regular decrease of the standard prices in our model.

This assumption allows to calculate the total fixed broadband market volume over the period 2007-2015.

Step 5: Evaluate the annual investment volumes over the period 2006 - 2015

Three kinds of investment costs are considered for each technology:

- Coverage costs: this is the investment needed to extend the reach of a technology (backbone, upgrade of the MDFs, local loop), independently of the number of subscribers. The annual volume of this investment is calculated for each technology on the basis of the increase in coverage.

- Upgrade costs: this is the investment needed to increase the available bandwidth without fundamentally changing the technology, such as an upgrade from ADSL to ADSL2+, or from UMTS to HSDPA. This is mostly an upgrade of the active devices of a network, without laying new cables. The annual volume of this investment is calculated for each technology on the basis of the number of subscribers.

- New connection costs: this is the investment cost needed to open a new connection (routers, terminal equipment). This does not include non-investment costs such as marketing and service. The annual volume of this investment is calculated for each technology on the basis of the new subscribers.

These investment costs mostly depend on the cost of electronic hardware on the international market. They are considered the same for all countries. A price deviation (yearly decrease) has been assumed for each technology and each kind of cost.

	ADSL	VDSL	Cable modem	FTTx	Fixed Wireless	Mobile 3G/4G
Coverage costs	170 €	350 €	100 €	2,500 €	300 €	200 €
Upgrade costs	10 €	10 €	10 €	10 €	10 €	20 €
New connection	80 €	80 €	80 €	200 €	100 €	40 €

Table 5 - Investment costs for each technology, 2006
Source: our calculations

These evaluations combined with the previous results of the model allow to calculate the total investment volume over the period 2006-2015.