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EuP Preparatory Studies

Lot 26: Networked Standby Losses

Final Report Task 3

Consumer Behaviour and Local Infrastructure

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3 Task 3: Consumer Behaviour and Local Infrastructure

The subsequent analysis has been modified from the given methodology in order to serve the particular purpose of this horizontal study on networked standby. The Task 3 report is structured into three subtasks.

Subtask 3.1 deals with real life efficiency. Based on selected use examples we will discuss typical application scenarios for networked standby mode including different use conditions and types of users. The objective is to identify use cases and parameters in support of the later base case assessment.

Subtask 3.2 deals with user requirements. By placing Networked Standby Mode in the context of real life use conditions, different products, and consumer behaviour we will identify important user requirements that could have an influence on ecodesign requirements.

Subtask 3.3 deals with use patterns. In order to calculate the overall environmental improvement potential of networked standby mode it is necessary to allocate typical use patterns to the selected scope of products.

Subtask 3.4 deals with the local infrastructure. Provider based services for accessing television programmes, the internet, and voice telephone is a necessary infrastructure which could lead to networked standby utilization.

3.1 Real-life efficiency

3.1.1 Introduction

The general intention of facilitating low power Networked Standby Mode is reducing the energy consumption of the product while maintaining the quality of service sought by the consumer, namely reactivation of the product by a legitimate command from another device via a network in an acceptable amount of time. This measure is, in principle, environmentally beneficial, because it has a realistic potential to save substantial amounts of energy in the use phase. In addition to the technical aspects of product design, the user and use conditions are important factors in the equation. Unfortunately, due to the novelty of the topic, there are no statistically firm field data regarding real life utilization of networked standby mode available yet.

In this subtask we will analyse typical use or application scenarios in order to identify relevant use parameters and user requirements. We will focus on mass consumption applications in the home and office environments. We make assumptions regarding typical network technologies, networked products, network-based services and sample applications. Our perspective on these aspects is not limited to the current status. We will assume a mid-term time horizon for the investigation.

3.1.2 Wake-up of imaging equipment over LAN

The first typical example for reactivation via network is a printer.[1] Most printers today feature an advanced power management, which shifts the devices after fulfilling a print-job into lower power states in order to save energy. Let's assume that this lower power state provides network integrity communication and the capability to wake-up by network command. The device maintains network integrity and waits to receive a new print-job from a personal computer or server. When this command arrives via network, the printer shifts into active mode in order to fulfil the required task.

Exemplary aspects:

- Network activity: User activates from a computer terminal the locally networked imaging equipment in order to conduct a print job.

[1] According to common network terminology, the printer in our example is a typical network endpoint (terminal or client devices) which is connected or networked to the redistribution equipment (host or server). The equipment that build communication networks are generally considered as nodes.

- Networked devices: Products involved are personal computers (e.g. Desktop PC, notebook) and the imaging equipment (printer, multifunctional device) with the option of a network device (bridge, switch, and router) as a link.
- Network options: Wired LAN (USB, Ethernet) or wireless LAN (WiFi, wireless USB, Bluetooth or Firewire).
- Power management: Imaging equipment typically provides power management that immediately shifts the device into a “ready state” after the print job and shortly later into a “sleep state” that provides network integrity communication.
- Subsequent power requirement in active mode: In the case of printers the power consumption in active mode depends on the imaging technology and speed of the equipment (see TREN Lot 4). It can range from under 15 Watt for simple inkjet-machines to more then 1500 Watt for high speed laser-machines. This example indicates that the rated power consumption of the power supply unit (PSU) could have a significant influence on the power consumption level in low power networked standby mode just through the conversion losses of the PSU, if an non-optimised design is used.
- Reactivation time: The latency period between network command and active operation is a technical aspect as well as an important user requirement. In the case of printers a latency period of a few seconds (10-15 sec) is acceptable. The latency time depends on the signal/image processing (digital front end) and the imaging/printing technology.[2]

3.1.3 Wake-up through Virtual Private Network

The second example is a personal computer or small server in home and small office environments. Broadband communication and virtual private networks (VPN) allow for instance users today to access their databases on their computers remotely via fixed or mobile networks. Wake-on-LAN (WoL) is a feature available in most computers today. It provides remote reactivation via network from a low power state, such as the sleep mode (ACPI S3).[3] The WoL-option is most often not preset in conjunction with sleep mode and has

[2] For more details regarding these aspects please refer to the final report of TREN Lot 4 (see: http://www.ecoimaging.org).

[3] According to ENERGY STAR® definition:
Wake-on-LAN (WOL): Functionality which allows a computer to wake from Sleep or Off when directed by a network request via Ethernet.

to be enabled by the user in the system (BIOS). The ENERGY STAR® program requirement for computer allows a "functional adder" of 0.7 Watt for Wake-on-LAN in conjunction with sleep mode.[4] The home and small office PC example is also characterized by access networks with increasing bandwidth/speed but with less complex network topology than in larger office environments. Note that WoL from the soft-off state of a computer (e.g. ACPI S5) is also possible, but is not considered an Off-mode in the EuP sense, but rather belongs to networked standby.

Exemplary aspects:

- Network activity: User is activating his home computer from outside over a virtual private network (VPN) in order to retrieve files (e.g. address book, documents, pictures, videos).
- Networked devices: Initiating device (mobile device, external computer), network device (home gateway, LAN router), receiving device (home computer, storage device)
- Network technology / interface: Wired LAN (Ethernet) Wireless LAN (WiFi), Cellular Wireless (UMTS, LTE)
- Power management: Home gateway and network is active or provides network integrity communication for immediate repose (latency time millisecond to <5 seconds). Wake-on-LAN is activated at the home computer.

Sleep Mode: A low power state that the computer is capable of entering automatically after a period of inactivity or by manual selection. A computer with sleep capability can quickly "wake" in response to network connections or user interface devices with a latency of ≤ 5 seconds from initiation of wake event to system becoming fully usable including rendering of display. For systems where ACPI standards are applicable sleep mode most commonly correlates to ACPI System Level S3 state (suspend to RAM).

[4] ENERGY STAR® V4.0: 4.0 Watt sleep-mode allowance for desktops, integrated computers, desktop derived servers and gaming consoles. 1.7 Watt sleep-mode allowance for notebooks and tablet PCs.

ENERGY STAR® V5.0: Energy efficiency for desktops and notebooks is only measured by TEC value. No specific sleep mode and Wake-on-LAN allowance are specified. For small scale servers and thin clients the latest version specifies 2.0 Watt off mode and 0.7 Watt allowance for Wake-on-LAN.

3.1.4 System administration

The third example is another WoL-application typically in office environments where a system administrator needs remote access to a larger number of distributed computers over the LAN-infrastructure. This example can have two basic scenarios. In the first scenario the administrator requires a “full” reactivation in order to initiate a larger service update or other task, which requires a shift into active mode. In the second scenario the administrator might only want to monitor the status of the distributed computing equipment and manage security, while maintaining the equipment “out-of-band” or in “networked standby mode”. For this kind of remote system administration various companies have developed specific technologies.

This includes technologies using the industry standard DASH (Desktop and mobile Architecture for System Hardware) Version 1.1.0 from the DMTF (Distributed Management Task Force). DASH provides a standard for secure remote management, including out of band management, of desktops and mobile systems. This allows administrators to power off systems or put them into sleep or hibernate states more often, thus reducing power requirements. DASH systems also support management and monitoring tasks without requiring that the system be powered on. DASH standard support is offered by a wide variety of vendors.

Another example Intel’s Active Management Technology (AMT) built into personal computers with vPro Technology.[5] This proprietary technology provides energy saving potential also due to the avoidance of “full” reactivation of the equipment for general task of remote system administration. On the other hand the power consumption of this solution can be somewhat higher than the 0.7 Watt allowance for “simple” Wake-on-LAN solution.

In conclusion, industry stakeholders indicate that most computers sold to private customers have the WoL functionality (in preset) deactivated. In case of business customers WoL is typically activated. IT-Administrators in business offices usually utilize WoL for servicing the larger and more distributed computer (computing) infrastructure. There are also many computers available that support wake up using DASH, which utilizes a web services protocol, thus making DASH wake-up an attractive alternative to Wake-on-LAN.

[5] For information on Intel AMT see: http://www.intel.com/technology/platform-technology/intel-amt/ For information on other out of band management technologies see dmtf.org/sites/default/files/standards/documents/DSP2014_1.1.0.pdf, www.amd.com/us/Documents/47159A_01_DASH_2_0_UseCases.pdf ; and developer.amd.com/cpu/manageability/Pages/default.aspx

3.1.5 Home entertainment

The fourth example is related to the TV and consumer electronics environment. The reactivation functionality in this case is a provider initiated broadcasting including random service up-dates for set-top-boxes and automatic program download. The power consumption level of the residential broadcast interface might be influenced by the type of broadcast access technology (e.g. DVB-T, DVB-S, DVB-C, and IPTV). Further power requirements derive from subsequent functionalities such as video recording or audio systems (not the actual recording, but the readiness for recording etc.). Networked standby mode in the field of consumer electronics (television, audio and video) is also characterized by a large diversity of network interfaces employed and respective protocols (HDMI, DVI-D, VGA, SCART, etc.).

3.1.6 Home Gateway and network

The fifth example is related to LAN infrastructure and customer terminals, which require near zero latency period reactivation. The example covers a whole range of products including wired modems and gateways, wireless network access points, LAN repeater, hubs, switches and routers, as well as terminal devices including conventional and IP-based telephones and to lesser degree facsimile machines. In this field we find analogue technology on the one hand and high speed digital technology on the other. The common denominator seems to be millisecond reactivation requirement in case of possible networked standby mode. This example is also useful to investigate network-related power management solutions with implications for the eco-design of equipment. For example, IEEE 802.3az task force (Energy Efficient Ethernet) is exploring methods for scaling Ethernet link rate as a function of utilization to save energy. Since integrity communication and wake-up messages are principally low bandwidth this could be useful during networked standby if the connected products all employ this new feature.

Power consumption is influenced by activated display (on hook). DECT telephone / or VoIP telephone is enabled to detect incoming calls, status display is active (the type and size of the display influences power consumption) option to reduce power consumption is to deactivate the display and just obtain status information through a LED.

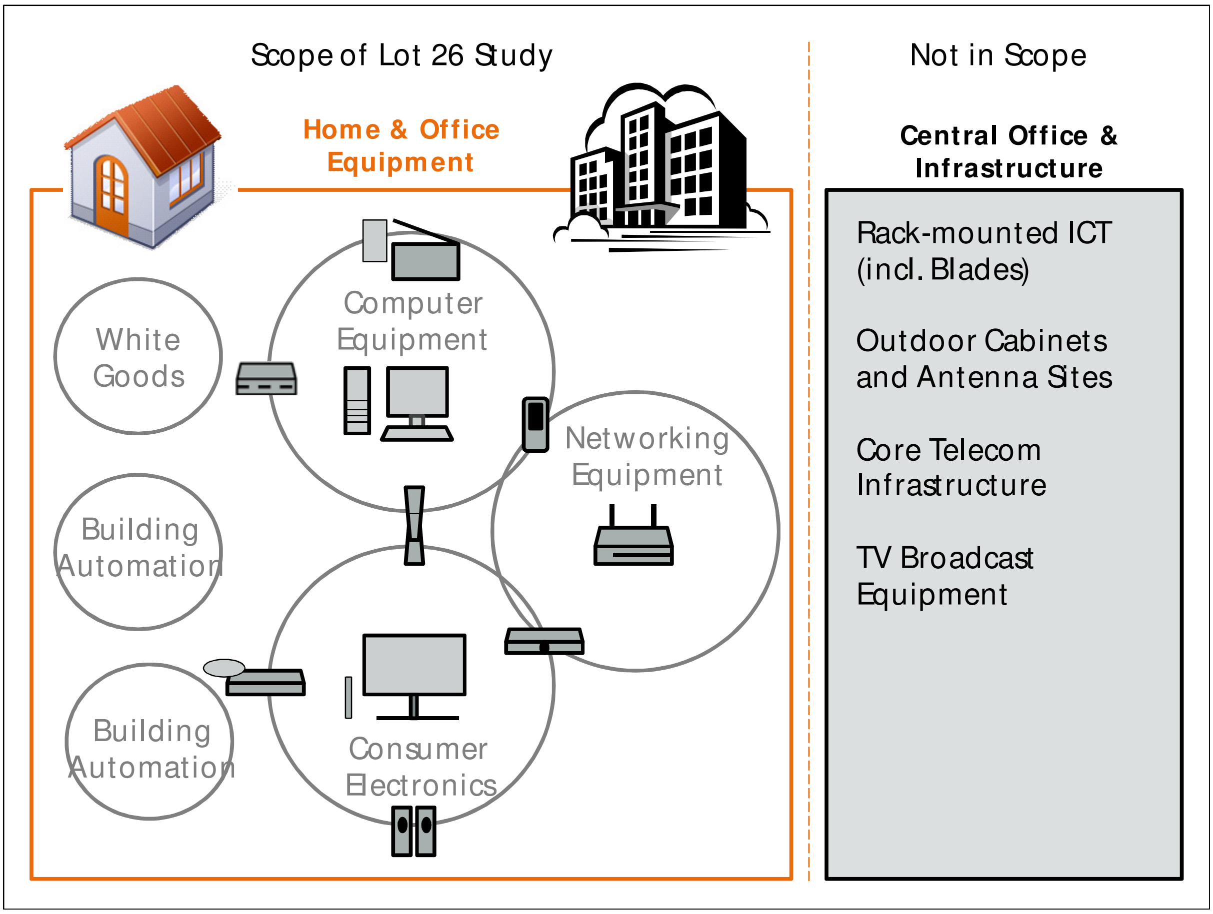

Figure 1: Scope of Lot 26 assessment

3.2 Use parameters and user requirement

3.2.1 Basic use parameters

The objective of this subtask is to define the basic use parameters that will be needed for the later environmental impact assessment. The use parameters define the daily and annual use pattern which we will apply to the base case (specific assessment) and the representative product scope (EU-27 total assessment).

The daily use pattern considers the average duration in terms of hours per day (h/d) which a product is in a certain power state or mode. Of interest to the study are the time durations and respective power consumption related to:

- Operation: including the active modes “operation”, “maintenance”, and “download”
- No-load/Idle: including the active mode “no-load” and low power/sleep states similar to “idle”
- Networked: including the standby mode “networked standby/network integrity” as well as WoL sleep modes (S3)
- Standby/off: including all other standby modes (status information, reactivation) and off modes (off with losses, off without losses)

The distinction of active operation and idle has the reason, that for certain products with relatively low power consumption in operation mode (>10 to <30 Watts) the no-load or idle mode could mean a low power state or power consumption (>1 to <10 Watts) comparable to networked standby mode. Due to the fact that both “no-load/idle” and “networked standby” could be interchangeable for certain products means that we have the option of calculating different scenarios such as “no-load/idle” as part of active mode or “no-load/idle” as part of networked standby mode.

The specific distinction of all other standby and off modes seems to be not necessary due to the now regulated maximum power consumption of 1Watt or less (EC 1275/2008). In terms of functionality the “Networked standby” is not interchangeable with the other standby and off modes. We therefore combine all other standby and off modes into one mode. With respect to the environmental impact assessments we have the option to calculate different scenarios for total energy e.g. with 1 Watt in the midterm and 0.5 Watt in the long term.

Task 3.3 provides daily use pattern assumptions for the selected reference products. The assumptions for the mode durations are mostly deriving from established sources such as Energy Star test procedures and EuP preparatory studies. Please note that these use pattern assumptions are rough averages. They intend to cover the full spectrum of users and product variations. Although very rough they provide a base for the impact assessment and modified impact scenarios. In real life products are configured and used with extreme diversity. In the following section we will discuss some user requirements or user aspects that potentially influence the utilization of networked standby mode and its level of power consumption.

3.2.2 User requirements

If it were possible, consumer preferences would be for the services their devices provide to be instantly available from anywhere in the world. As discussed in Section 2, consumer electronics are increasingly including networking capabilities in order to meet the demand for access. As will be discussed in Section 5, this increasing access, however, comes at cost in terms of energy, especially when active and idle power modes are used to provide the desired level of availability (i.e. the speed at which the device is reactivated). The central challenge for product designers, then, is to ensure that the consumer can enjoy the desired quality of service, while minimising energy consumption.

Well-designed networked standby mode as an integrated part of power management has a strong potential to reduce overall energy consumption. In order to be accepted by the consumer it is necessary that the product which features networked standby mode fulfils certain requirements. Due to the novelty of the issue statistical data regarding consumer requirements are not available. However, based on the results of previous EuP preparatory studies it seems justified assuming that consumer requirements include:

- Reliability: Smart and reliable operation while the product is set to networked standby mode. This means that the product remains in a specified power level and only reacts to authorized/legitimate user commands and avoid false wake-ups.
- Security: Secure operation while the product is set to networked standby mode. This means that the product has a defined degree of protection against assaults over the network. The user might ask: is it safe to use networked standby mode.
- Transparency: The user should be able to recognize the networked standby status of his product without the need to reactivate it. The user might ask: is the device still online.
- Automation: Automated power management that shifts the device into networked standby mode according to software presetting or manual mode setting option. The consumer needs simple and intuitive software setting options.
- Convenience: Fast and reliable reactivation of the product out of networked standby mode. The user might ask: how fast is it possible to reactivate the product for main operation. The reactivation time (latency) is closely connected to the type and configuration of the product as well as the type and environment of application. Best

example is the EP-printer that needs a certain amount of time to heat up the fixing unit and is therefore in e.g. a front desk situation set to a prolonged ready/idle mode and not low sleep/networked standby mode.

- Energy Efficiency: Low energy consumption is a considerable user requirement not only reflecting increasing environmental awareness but also sensibility in terms of operation expenditures.

The combination of these aspects will influence the power consumption, presetting, and actual utilization of a product. These aspects will be reflected in the technical analysis.

3.3 Use pattern assumptions

According to the MEEuP (methodology for conducting EuP preparatory studies) it would normally be required at this point to provide use pattern assumptions to be used later in the base case assessment (Task 5). In principle, the use patterns should reflect an average real-life utilization of products. Such typical or averaged use patterns exist for a few product groups such as PCs or certain printers. Most of the available typical use patterns have been developed in conjunction with the Energy Star Program and the testing of so called Typical Electricity Consumption (TEC). More specific use patterns which differentiate various types of users (e.g. heavy user) or areas of application derive from commercial market survey or individual user studies on a corporate level. Although such more specific studies are highly educational it is often difficult to validate the information.

With respect to this study, the challenge for providing averaged use patterns for the selected representative product groups is considerable. In the preceding draft reports we mostly allocated established use patterns to certain product groups based on existing structures used by the Energy Star Program or in previous EuP studies. However, as we introduce the concept of network availability in the course of the study, use pattern assumptions for individual product groups was superseded by conducting specific purpose scenarios. This approach has been welcomed by some stakeholders and criticised by others. For the authors of the study the use patters became an instrument for showing the extent of the networked standby. The real-life scenario for any product group is likely to be some combination of the four network availability scenarios.

Note: Full details of the scenarios, the hours per day spent in each mode are presented for each product group and network availability scenario in the annexes of Task 5. Given the particular use patterns of specific product groups, each base case is calculated from individually chosen parameters (see Section 5.3).

3.4 Local infrastructure

3.4.1 Broadband coverage[6]

The growth of fixed broadband connectivity has been steady, with high year-on-year growth rates that in some years equalled more than 20 million new broadband lines. As a result, the percentage of households with a broadband connection has jumped from 33% in 2004 to 48% in 2008, with broadband connectivity in enterprises increasing from 46.5% in 2004 to 81% in 2008. There are an additional 12% of households with a non-broadband connection in 2008, leaving 40% not connected.

Fixed broadband penetration (number of fixed broadband lines per 100 inhabitants, including both households and enterprises) increased from 17 in 2004 to 23 in 2008. There is significant variation among Member States: Denmark leads with a penetration rate of 37, while Slovakia trails with 11, as seen in Figure 2. However, as shown in Figure 3, the trend shows that the gap in broadband penetration is decreasing. This gap is due to a levelling off of growth in countries with the highest penetration rates, while countries with little penetration have experienced significant growth rates.

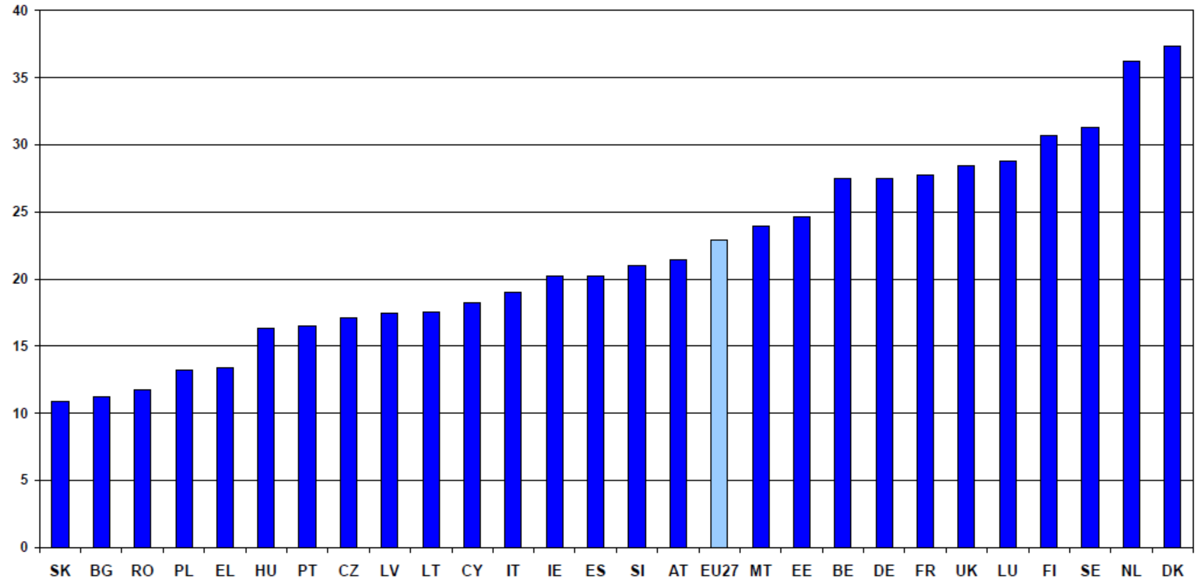

Figure 2: EU-27 Broadband penetration, January 2009

[6] SEC(2009) 1103 http://ec.europa.eu/information_society/eeurope/i2010/docs/annual_report/2009/sec_2009_1103.pdf

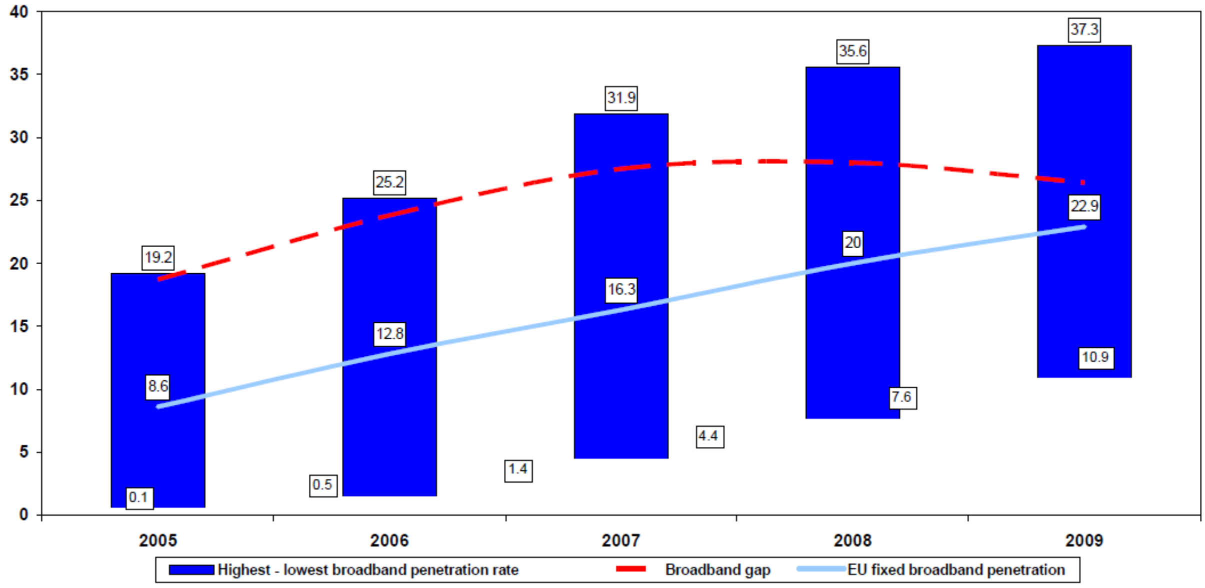

Figure 3: The gap in broadband penetration in the EU

Broadband coverage is most commonly provided by DSL services using the traditional phone network, followed by services provided over the cable lines. DSL coverage is used as a proxy measurement for broadband coverage, as coverage with cable service normally overlaps that of DSL. As shown in Figure 4, the coverage in the EU has increased from 89% of the population in 2005 to 93% in 2008. Significant progress is being made in the Member States at the lower end of the spectrum, highlighted by Greece increasing coverage from 0% in 2005 to 86% in 2008. This extension of coverage to the vast majority of the population is expected to continue.

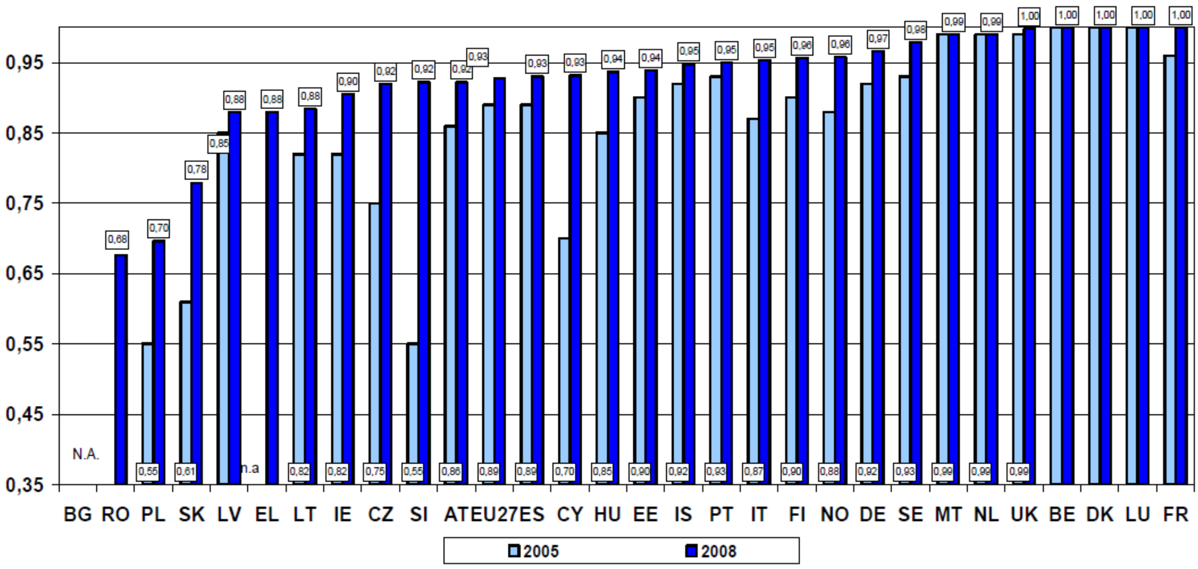

Figure 4: Growth in DSL national coverage in the EU, 2005-2008 (percent of total population)

Recently, advanced fixed technologies based on optical fibre, as well as wireless technologies such as UMTS (3G), WiFi, WiMAX, and satellite have made inroads into the broadband market. Wireless access appears to have the potential of providing broadband access in isolated and less populated areas. The use of wireless broadband networks is a topic currently being studied by the EC.

The Broadband Performance Index (BPI) was developed by the EC in order to:

- measure relative performance of countries in the wide broadband economy
- identify relative weaknesses and strengths of individual countries to fine-tune policy making
- better understand the relative propensity of countries to progress in the broadband economy

The BPI is structured along six dimensions: broadband rural coverage, degree of competition, broadband speeds, broadband prices, take up of advanced services and socio-economic context. The results are shown in Figure 5. Sweden leads the index with a 0.76 while Cyprus is trailing with a 0.18.

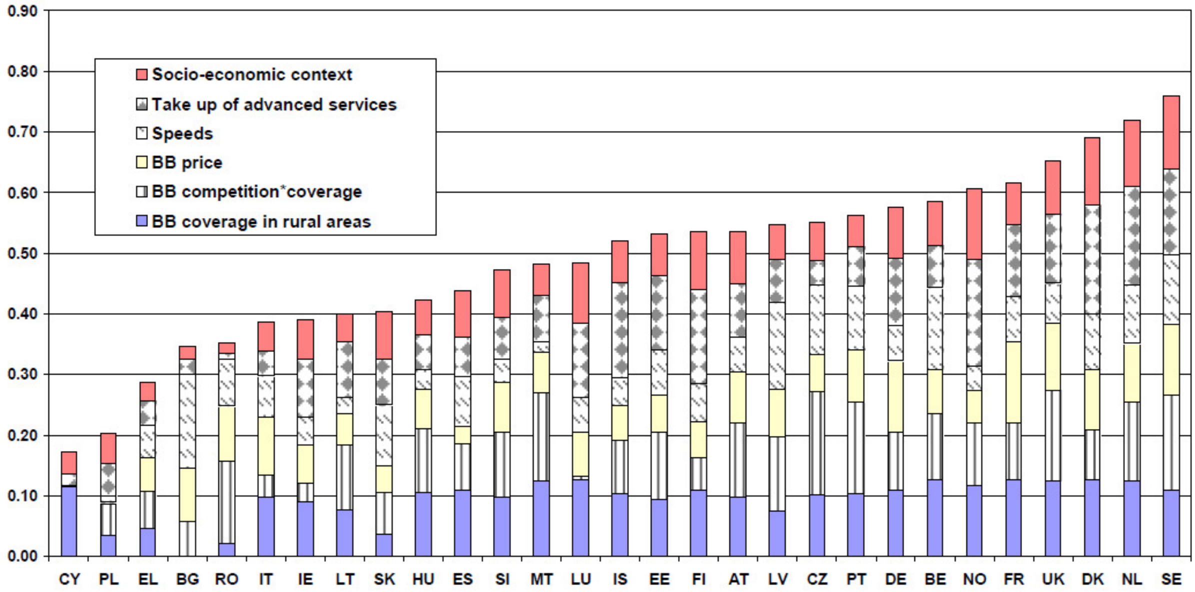

Figure 5: Broadband Performance Index, July 2009

3.4.2 Television (TV)

Television penetration has been steadily increasing over the past few years, and this trend is expected to continue in the future as TV services begin to be delivered using more advanced methods. Table 1 breaks down the delivery of TV services within Europe. As the table shows, satellite is currently the preferred method of delivery with 37% of households, but both terrestrial TV (32%) and cable TV (22%) not far behind. IPTV is growing the most quickly, experiencing an increase of 465% from 2005 to 2010.

Table 1: Penetration of TV service protocols in Europe (millions of households)[7]

	2003	2004	2005	2010
Cable	6.4	7.6	10.2	28.9
Satellite	22.9	25.0	28.4	49.1
Terrestrial TV	3.7	8.1	14.2	42.2
Internet (IPTV)	0.4	0.6	2.0	11.3
Total	35.0	41.3	54.8	131.3

As part of an agenda supported by the EC, Member States have gradually been making the switch from analogue to digital television.

[7] Article extracted from Le Journal du net : Le marché de la télévision par câble-satellite en Europe (2004)

As shown in Table 2, the television infrastructure is currently in a state of change, as Member States gradually switch from analogue to digital delivery. Currently, seven Member States have phased-out analogue television.

Table 2: Digital television switch in Europe[8,9]

	% TV penetration	Number of channels offered	Economic model	Analogue phase-out	Date of phase-out
Belgium (Flanders)	-	3	Free	Yes	2008
Denmark				Yes	2009
Finland	54	33	Free / Pay	Yes	2007
Germany	11	47	Free	Yes	2008
Luxembourg	-	12	Free	Yes	2006
Netherlands	10	41	Free / Pay	Yes	2006
Sweden	18	35	Free / Pay	Yes	2007
Austria	12	8	Free	No	2010
Belgium (Wallonia)	-	7	Free	No	2011
Bulgaria				No	2012
Cyprus				No	2011
Czech Republic	10	12	Free	No	2012
Estonia	3.4	50	Free / Pay	No	2010
France				No	2011
Greece				No	~2012
Hungary	-	6	Free / Pay	No	2011
Ireland				No	-
Italy	32	61	Free / Pay	No	2012
Latvia				No	2011
Lithuania	1	54	Free / Pay	No	2012
Malta	-	69	Pay	No	2010
Poland				No	2015
Portugal				No	-
Romania				No	2012
Slovakia				No	2012
Slovenia				No	2010
Spain	50	21	Free	No	2010
United Kingdom	37	48	Free / Pay	No	2012

8 http://www.obs.coe.int/about/oea/pr/miptv2009_mavise.html
9 COCOM09-01, Information from Member States on switchover to digital TV, 2009.

In addition to the trend in digital infrastructure, consumers have been purchasing an ever increasing amount of HD televisions to accommodate waves of high-quality HD channels. It is estimated that the penetration rate of HD capable TVs will reach 70% by 2012, with 44% expected to be receiving HD television content[10].

As of 2008, there were 78 HD channels in Europe, as seen in Table 3 and Table 4[11]. Expecting the increasing trend to continue, it is estimated that there are currently over 100 HD channels.

Table 3: HD Channels in Europe (Mid 2008)

HDTV channels by country and launch year						
	2004	**2005**	**2006**	**2007**	**2008**	**Total**
Belgium				5	3	8
Denmark					2	2
France			4	7		11
Germany		2	3			5
Italy			4	1		5
Netherlands			2	3		5
Spain				1	1	2
Sweden			1	2		3
UK			10	1		11
Pan-Nordic		1	2	2	2	7
Other (& pan-European)	1	1	6	10	1	19
Total	1	4	32	32	9	78

Table 4: Thematic HD channels in Europe

HDTV channels by genre and launch year						
	2004	**2005**	**2006**	**2007**	**2008**	**Total**
Children				1		1
Documentary			11	6		17
Entertainment		1	4	2	1	8
HD specialist[1]	1	1		2	1	5
Movies			6	5	2	13
Music				1	1	2

[10] Clover, Julian. "Strategy Analytics: 44% of Euro homes HD by 2012", Broadband TV News, 18 April 2007. http://www.broadbandtvnews.com/2007/04/18/strategy-analytics-44-of-euro-homes-hd-by-2012/

[11] European Broadcasting Union, Strategic Information Servce. HDTV in Europe. January 2009. http://www.ebu.ch/CMSimages/en/HDTV_Exec%20sum_Final_tcm6-64451.pdf

National[2]		2	3	8		13
Premium[3]			2	2	2	6
Sports			6	5	2	13
Total	1	4	32	32	9	78
[1] HD Specialist: e.g. HD1 [2] "National" channels: nationwide free-to-air general interest channels (e.g. BBC HD, TF1 HD) [3] Premium as a genre: "Canal+" type channels offering mix of premium movies and sports						

The recently developed WirelessHD specification defines a wireless protocol that enables consumer devices to create a wireless video area network (WVAN) with the following characteristics[12]:

- Stream uncompressed audio and video at up to 1080p resolution, 24 bit colour at 60 Hz refresh rates
- Deliver compressed A/V streams and data
- Advanced A/V and device control protocol
- Unlicensed operation at 60 GHz with a typical range of at least 10 m for highest resolution HD A/V
- Smart antenna technology to enable non line of sight (NLOS) operation
- Data privacy for user generated content

3.4.3 Mobile penetration

Mobile penetration has increased yearly for decades within Europe. In 2005, it reached 100% and is now beyond, meaning that there are more mobile subscribers than inhabitants in Europe, as shown in Figure 6. A penetration rate of over 100% does not necessarily mean that each person possesses a mobile phone; rather, that people often use more than one mobile phone.

[12] WirelessHD Specification Overview, August 2009, Wireless HD, http://www.wirelesshd.org/pdfs/WirelessHD-Specification-Overview-v1%200%204%20Aug09.pdf

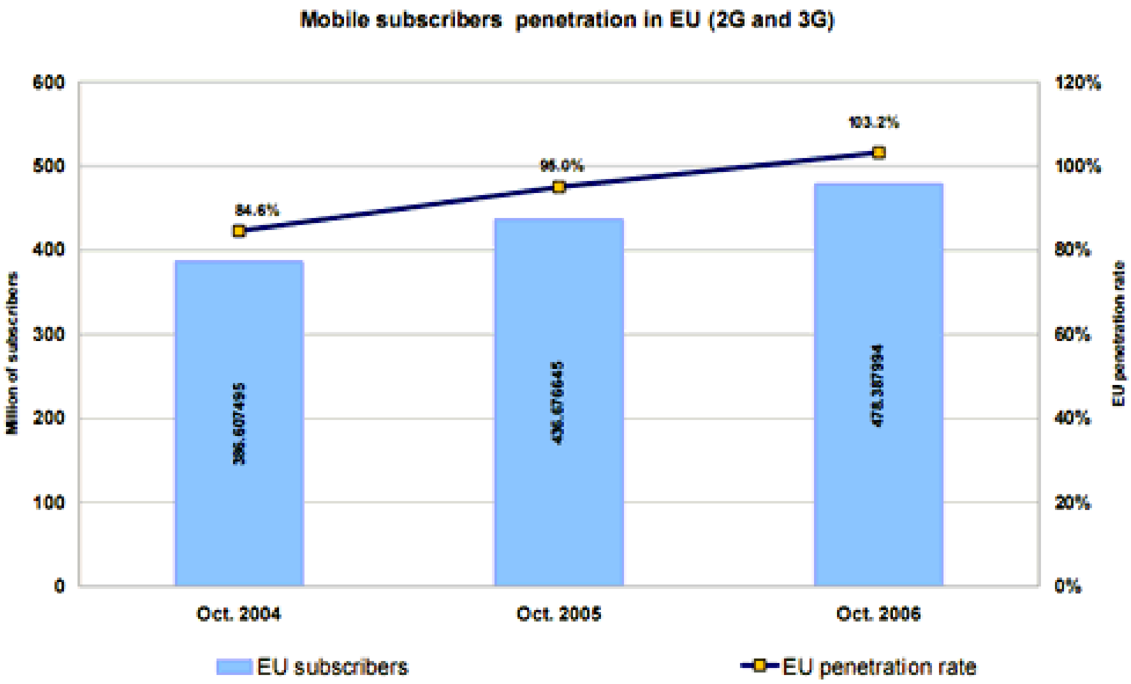

Figure 6: Mobile subscribers in the EU[13]

The repartition per country shows most of the countries have more than 100% of mobile penetration except France, Latvia and Malta, as seen in Table 5.

Table 5: Mobile penetration per country[14]

	Number of subscriptions (millions)	Mobile penetration (%)
Austria	11.1	133
Belgium	12.2	114
Bulgaria	10.6	140
Cyprus	1	118
Czech Republic	13.8	134
Denmark	6.5	120
Estonia	2.5	188
Finland	6.8	129
France	58	91
Germany	107	130
Greece	17.9	155

[13] Article from 3g.co.uk "45 Million 3G Subscribers in Europe" (2007) available at: http://www.3g.co.uk/PR/April2007/4516.htm

[14] ITU World Telecommunication/ICT Indicators Database. Available at:http://www.itu.int/ITU-D/icteye/Reporting/ShowReportFrame.aspx?ReportName=/WTI/CellularSubscribersPublic&RP_intYear=2008&RP_intLanguageID=1

Hungary	11.7	116
Ireland	5.3	121
Italy	89.4	154
Latvia	2.2	98
Lithuania	5	151
Luxembourg	0.7	147
Malta	0.4	94
Netherlands	19.9	120
Poland	44.4	117
Portugal	14.9	140
Romania	28.2	131
Slovakia	5.5	101
Slovenia	2.1	102
Spain	52.5	115
Sweden	10.3	113
United Kingdom	74.3	122