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European Perspectives on the Information Society: Annual Monitoring Synthesis and Emerging Trend Updates

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PREFACE

This report is the compilation of an Annual Monitoring Synthesis (AMS) Report and five Emerging Trend Updates (ETU) prepared during the EPIS06[1] project as building blocks for the development of an observatory of trends in technology and business evolutions of ICT.

The Annual Monitoring Synthesis Report (AMS Report) aims to identify new ICT-related developments likely to have a significant impact on the future of the Information Society, both in terms of growth and jobs for Europe and R&D policy prioritisation. By scanning and monitoring recent major foresight exercises and industrial technology roadmaps, as well as other future-oriented analysis and policy papers, the AMS attempts to detect early signals and possible disruptive forces so as to enable timely policy responses or even to anticipate potential challenges for policy makers. The AMS is structured along six main themes which emerged as a result of the analysis:

- Convergence of infrastructures
- Human-computer convergence – technologies for direct human-computer interaction
- Pervasive or ubiquitous computing and ambient intelligence
- The future of the internet
- Citizens' concerns
- Working life

A structured overview with a summary of each of the foresights, roadmaps and other sources studied is presented in the annexes to the AMS report (see pages 74 – 143).

In addition, five Emerging Trend Updates (ETU) present the results of focused briefs on emerging themes of interest for policy making, covering the following topics:

- ETU1 on the State-of-the-Art of the Creative Content Sector,
- ETU2 on ICT and the Offshoring of Services,
- ETU3 on ICT and the Role of ICTs as Enabler for Energy Efficiency,
- ETU4 on ICT Tools and Services in Intelligent Domestic and Personal Environments,
- ETU5 on ICT and Privacy in the Knowledge Society – The Case of Search Engines.

[1] European Perspectives on the Information Society

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ANNUAL MONITORING SYNTHESIS REPORT

EPIS Work Package 1 – Deliverable 1.1

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** The ETEPS AISBL – European techno-economic policy support network was set up on the initiative of the IPTS in 2005 by 19 effective members from 15 EU Member States. It further counts 19 associated members worldwide and is supported by a network of external organisations. Its main mission is to provide intellectual services for carrying out techno-economic and policy-related studies in the context of EU policy-making. See www.eteps.net for further information.*

EXECUTIVE SUMMARY

This Annual Monitoring Synthesis Report (AMS Report) - one of the main outputs of the EPIS Project (European Perspectives on Information Society) - aims to identify new ICT-related developments likely to have a significant impact on the future of the Information Society, both in terms of growth and jobs for Europe and R&D policy prioritisation. By scanning and monitoring recent major foresight exercises and industrial technology roadmaps, as well as other future-oriented analysis and policy papers, the AMS attempts to detect early signals and possible disruptive forces so as to enable timely policy responses or even to anticipate potential challenges for policy makers.

In today's context of rapid technology advances, ever wider reaching fields of technology application, changing user behaviours and constant information overflow, trying to understand the future is a complicated task. Foresight and futures studies have emerged in recent years as very valuable tools to detect seeds of change and anticipate possible disruptions, where forecasting or extrapolation would not suffice. The benefits of foresight go beyond imagining a possible future, as the foresight process itself helps to develop a common vision, creating a "forward thinking" culture and changing mindsets.

By developing a foresight observatory at European level, analysing national foresight results and other forward looking studies from Europe and beyond, the AMS provides a unique source of knowledge for policy makers, which points to promising avenues for research and development and at the same time, highlights potential tensions, thus contributing to a better informed policy making process for Europe.

A number of technology and societal developments have emerged from the AMS analysis which will pose some important challenges for Europe. These will need to be tackled if Europe is to remain competitive in the 10-15 years to come. As a matter of priority, EU policy should pay particular attention to the following:

- Supporting R&D for the human brain interface which is the most promising area likely to revolutionise the way we do things;
- Supporting R&D for more efficient ICTs i.e. encouraging ICT innovation while preserving sustainability;
- Creating a favourable environment for attracting knowledge workers (e.g. taxation, mobility).

The above are part of a broader set of issues for policy makers' attention, as they are likely to have an impact on Europe's positioning in ICTs-related industries. They are presented in more detail below.

Convergence of ICT infrastructures

Progress towards the convergence of networks for ICTs into a single, **seamless broadband infrastructure** has been quite steady, although the smooth transition to mobile communications still depends on the provision of sufficient wireless bandwidth. **Storage** technology has made massive progress, both in terms of capacity and access speed. There are alternative technologies in the shape of upgraded **hard-disk technology** and **flash memory**. Mobile applications depend crucially on improvements in power technology. One alternative is the use of more energy efficient technologies, but progress is also being made in the development of **power scavenging technologies** and the use of **ambient energy**.

There is still discussion on simplification of computers by locating software and storage on the network rather than the user's desktop, **making computing a utility,** like electricity, water or gas. This vision is encountering resistance from major incumbents. The feasibility of promising alternative architectures, such as **DNA computing**, **nanomolecular computers** and **quantum computers**, has been demonstrated in principle, but is still far from practical application. Supercomputing based on **grids and parallel architectures** is likely to be available in the near future, although its effective use will be restricted initially to large industries and ambitious research. **Parallel programming** is expected to massively increase in importance, requiring special programming skills and thus education and training of suitable programmers will be a major challenge.

Human-Computer convergence
The **convergence of NBIC** is a powerful vision not yet matched by reality, research results or even research programmes. There may be too much interest in applications to enhance human beings at the expense of more down-to-earth but nonetheless useful goals. One further vision related to convergence assumes that it will be possible to mediate **interaction** between personal electronic products by means of the **human skin**, resulting in convergence of **electronic implants, wearables** and **personal area networks**.

It is quite likely that there will be **implants** developed on the basis of converging technologies in the near future, initially for **therapeutic uses**, but potentially for **human enhancement**, which is likely to trigger controversial debate. Most experts feel that humans will still be in control of technology, but some fear that machines and processes beyond human control could be created.

Pervasive, ubiquitous and ambient computing
Pervasive computing, emotion-aware technologies and applications, and the Internet of Things will involve the massive roll-out of **RFID tags**, raising new concerns for **privacy and data protection**. Devices will include **objects** not normally considered as communicating devices, such as toys, household appliances, automobiles and clothing. Uptake will depend on the satisfactory trade-off between current notions of **privacy** and **data protection** against any benefits derived from services and products in an always-on, wired up environment.

The future of the Internet
The **Web2.0** phenomenon offers users the chance to be co-producers or "**prosumers**". Ultimately, this development could generate many jobs and businesses of types as yet unheard of. Beyond the Web2.0, a vision for the **Web3.0** - the **Semantic Web –** has already emerged**,** which consists of enriching data on the web with metadata conveying its meaning.

Citizens' concerns
Privacy and trust remain crucial issues for the realisation of many ideas and visions linked with future ICT use. Awareness of this fact among developers seems to be increasing. **Security** is an important item both as an application area for ICTs and as a requirement for ICT devices and infrastructures, although surveys show a growing lack of interest in implementing adequate security measures in industry. The **digital divide** is a concern in terms of access to digital technology and infrastructure, education/training and affordability needed

to participate in a knowledge society. Managing and safeguarding **intellectual property rights** and privacy through acceptable socio-technical solutions are another matter of priority.

Working life

There is **global competition** for well-educated, multi-talented staff needed to accomplish the transition to knowledge economy. A number of factors make Europe attractive as a location for such work but many regions throughout the world have discovered creative work as an important asset for their economic development and correspondingly have begun to produce statistics and strategies to help **attract creative workers** and industries.

The concept of pervasive computing may have negative implications for **work-life balance**, but it may also have positive implications for urban development and the environment. Last but not least, the vision of the **Personal Fabricator** could be of great interest as an extension of the "prosumer" concept into the physical world and also for its implications with respect to developing countries and environmental impact.

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1. INTRODUCTION

1.1 Context of the AMS report

One of the most mind-boggling information-technology announcements of 2007 was that LG Electronics had filed a patent application for an MP3 washing machine, or, to be more precise for a "home appliance with an MP3 player comprising the MP3 player adapted for storing contents; and a washing device for washing or drying clothes, the washing device being connectable with the MP3 player and having a communication function with the MP3 player to play back the contents stored in the MP3 player"[2]. While the casual reader of the headline might be expecting a spectacular miniature device capable, thanks to nanotechnology, of at least washing a traveller's socks and underwear while on the move, expert reaction has proved lukewarm, since the patent is simply for a port for an MP3 player in a conventional washing machine. "Why" asks one expert, "not just crank up the stereo or clip your iPod to your belt?"[3]

This news item illustrates very well the span of this report between futuristic developments for the long term future and rather incremental changes to technology already in existence today. It is also an example of what seems to be the buzzword characterising development in Information and Communication technologies in recent times: convergence, in this case between a household appliance and an entertainment device. We are, however, witnessing convergence in many areas related to ICTs: convergence between computers and various household consumer goods, convergence between previously separate networks for telecommunications, audio and audiovisual broadcasting and data transmission, convergence between the previously separate roles of producer and consumer, convergence between key technologies and sciences like in NBIC convergence (nano, bio, info, cogno), and finally at least visions of convergence between humans and machines.

1.2 Aims of the AMS report

The work programme agreed for the EPIS06 project foresees the production of an annual synthesis report (AMS Report), a report that synthesises main findings from recent major foresight exercises and industrial technology roadmaps. It should identify new insights and ultimately assess the value of foresight activities (in a broader sense), i.e. to what extent and in which form they provide novel insights. In a sense, EPIS06 picks up from where its predecessor FISTERA (Foresight on Information Society Technologies in the European Research Area) stopped: it has added findings from further national foresight studies and attempts to identify further technological developments with relevance for the future.[4]

In the first instance the report is based on an analysis of the existing literature. This consists mainly of reports from national foresight studies, other future-oriented analysis and policy papers, both from official (state) sources, industry and others (NGOs, research not commissioned by state or industry). In addition, a number of relevant internet sites were monitored regularly for news items of interest in view of the goals of the report.

2 Wood, L.: Next an MP3 washing machine? http://www.computerworld.com, July 27 2007.

3 Ibid.

4 Compañó, R. et al. (2006): Foresight on Information Society Technologies in the European Research Area (FISTERA) – Key Findings. Luxembourg: Office for Official Publications of the European Communities. EUR 222319 EN

Special attention has been given to so-called "disruptive technologies". Following Harvard professor Clayton M. Christiansen, disruptive technologies are defined as those that sacrifice certain qualities in a product that are attractive to a majority of customers in favour of a different set of characteristics favoured by a minority or also fulfilling a niche need. Disruptive technologies can also create new markets by radically changing the market landscape, e.g. by allowing new players to enter the market[5].Typical examples treated in this report are Voice over Internet Protocol (VoIP), Radio Frequency Identification (RFID) and Wireless Microwave Access (WiMAX).

1.3 Structure of the report

The report starts with a brief overview of the documents covered in the study, organised by type (national foresight studies, other foresight studies, technology-oriented studies).

Sections 2.1 to 2.4 deal with a number of important visions as follows:

- The convergence of infrastructure and related hardware developments
- Human-computer convergence and technologies for direct Human-Computer Interaction
- Pervasive or ubiquitous computing, ambient intelligence,
- The future of the Internet

The next section,–section 2.5, - is devoted to a number of "citizen concerns", challenges which might need the attention of policy makers:

- Privacy
- Security and trust
- Digital divides
- Intellectual property rights

A final section on developments and trends looks at working life, in particular the vanishing dividing line between work and leisure, the rise of the amateur, competition for creative workers, and personal fabricators.

The main findings are then summarised in the conclusion section. The annex contains brief summaries of the main documents used in the production of this Monitoring Synthesis Report.

[5] Cf. Robinson, N., Ortiz, D., Ligtvoet, A., Botterman, M., Valeri, L., Shoob, R., Nason, E. (2006)*:* Security Challenges to the Use and Deployment of Disruptive Technologies. Cambridge: Rand Europe, TR-406-EC, Final Report (D4) 29 September 2006

2. MONITORING RESULTS

2.1 Documents covered in the report

Table 1 gives an overview of the documents covered in this report. While FISTERA initially covered only national foresight reports, later phases extended the definition of foresight to embrace other forward-looking studies, such as the Roco/Bainbridge report for the National Science Foundation and US Department of Commerce on converging technologies[6], or RAND reports produced for the National Intelligence Council (NIC)[7].

Table 1 - Overview of studies analysed for the AMS Report

Bibliographic details of report	Type of study
Compañó, R., Pascu, C., Burgelman, J.C., Rader, M., Saracco, R., Spinelli, G., Dachs, B., Weber, M., Mahroum, S., Popper, R., Green, L., Miles, I. (2006): Foresight on Information Society Technologies in the European Research Area (FISTERA) – Key Findings. Luxembourg: Office for Official Publications of the European Community. EUR 22319 EN.	Multi-method foresight study on the ICT sector
National Research Centre for Science and Technology for Development, Research Group of Technology Foresight (2005): China's Report of Technology Foresight (Summary). Beijing, September	National Foresight Study
Commission on Vision 2020 (S.P. Gupta, chair): India Vision 2020, New Delhi December 2002	National Foresight Study
NISTEP – The National Institute of Science and Technology Policy (2005): Eighth National Japanese Science and Technology Foresight (2035). Tokyo:NISTEP	National Foresight Study
Institute for the Future, Stanford: Delta Scan: The Future of Science and Technology. Series of "briefs" on individual technologies/societal aspects for the UK Foresight directorate's Centre of Excellence for Horizon Scanning. Bulk of the database created 2005-2006.	National Foresight Activity with distinctly international dimension
Outsights- Ipsos-MORI: Sigma Scan. A collection of future issues and trends developed by the Outsights-Ipsos MORI partnership, commissioned by the UK Government's Horizon Scanning Centre at the DTI Office of Science and Innovation. Spring 2005, updated Autumn 2006.	National Foresight Activity with distinctly international dimension

6 Roco, M.C.; Bainbridge, W.S. (eds.): Converging Technologies for Improving Human Performance, 2002, http://www.wtec.org/ConvergingTechnologies.

7 Anderson, R.H., Anton, P.S., Bankes, S.C., Bikson, T.K., Caulkins, J., Denning, P., Dewar, J.A., Hundley, R.O., Neu, C.R. (2002): The Global Course of the Information Revolution: Technological Trends: Proceedings of an International Conference. Santa Monica: Rand
Antón, P.S., • Silberglitt, R. •Schneider, J. (2001): The global technology revolution : bio/nano/materials trends and their synergies with information technology by 2015. Santa Monica: Rand
Hundley, R.O., Anderson, R.H., Bikson, T.K., Dewar, J.A., Green, J., Libicki, M., Neu, C.R. (2000): The Global Course of the Information Revolution: Political, Economic, and Social Consequences Proceedings of an International Conference. Santa Monica: Rand

Tomorrow Project: Glimpses at a Glance	Private foresight activity sponsored by "subscribers". Mainly review of existing literature etc.
Holtmannspötter, D., Rijkers-Defrasne, S., Glauner C., Korte, S., Zweck, A. (2006): Übersichtsstudie Aktuelle Technologieprognosen im internationalen Vergleich, Düsseldorf: VDI-TZ	Synthesis of Foresight Studies on eight national innovation systems.
*CMI International, ICTAF, VTT, Z-Punkt, North Carolina State University, Institute for Industrial Interchange (2006)***:** Emerging Science and Technology priorities in public research policies in the EU, the US and Japan	Comparative study of research priorities.
Hundley, R.O., Anderson, R.A., Bikson, T.K., Botterman, M., Cave, J., Neu, C.R., Norgate, M., Cordes, R. (2001): The Future of the Information Revolution in Europe: Proceedings of an International Conference. Santa Monica: RAND	Proceedings of international conference on the "Information Revolution" from European angle
Silberglitt, R., Antón, P.S., Howell, D. R., Wong, A (2006).: The Global Technology Revolution 2020, In-Depth Analyses: Bio/Nano/Materials/Information Trends, Barriers and Social Implications. Santa Monica: Rand	2006 update of earlier RAND study covered in FISTERA
*Robinson, N., Ortiz, D., Ligtvoet, A., Botterman, M., Valeri, L., Shoob, R., Nason, E. (2006)***:** Security Challenges to the Use and Deployment of Disruptive Technologies. Cambridge: Rand Europe, TR-406-EC, Final Report (D4) 29 September 2006	Multi-method foresight on security aspects of "disruptive" technologies.
Montagne, R. (Ed.), Causse, A., Elnegaard, N., Ryan, D., Bråten, L. E., Le Floch, L.. Chira, L., Allen, S., Morozova, A., Sánchez, U. (2004): Broadband access roadmap based on market assessment and technical-economic analysis. Brussels, DG INFSO	Roadmap-like report on broadband access
Kenny, Lawrence (2006): Exploring the Business and Social Impacts of Pervasive Computing	Report on a series of workshops jointly organised by IBM Zurich Research Laboratory, Swiss Re Centre for Global Dialogue and TA – SWISS
Gonzalez, J.D (2002).: A Roadmap to Wireless: The State of the Technology. Atlanta: Air2Web	Industrial roadmap for consultant company
Elon University/Pew Internet Project (2005): Imagining the Internet: A History and Forecast. Elon, N.C.: Elon University.	Database of predictions looking forward up to 100 years
Anderson, J. Q.; Rainie, L. (2006): The Future of the Internet II. PEW Internet and American Life Project. Washington DC.	Ranking of priorities for the networked future with special section on funding priorities

ITU Internet Reports 2005: The Internet of Things. Geneva: ITU, 2005	Development of a vision "the internet of things" opening up new business perspectives for the telecommunications sector
Schroll, W.; Rodenhäuser, B.; Neef, A (2007).: Mash Up Your Business. Der Web 2.0 Report. Z_Punkt: Essen, Karlsruhe, Berlin	Information about Web 2.0 developments and their impact on businesses
*Nordmann, A. (Rapporteur)***:**Converging Technologies – Shaping the Future of European Societies, Brussels: European Commission, DG Research, 2004. EUR 21357	European concept of convergence. Report by a high-level expert group
Deutsche Bank Research (2006): Media Industry facing biggest upheaval since Gutenberg – Media consumers morphing into media makers. Frankfurt am Main: Deutsche Bank	Strategic analysis of changes in media industries
NCVO Third Sector Foresight (2007): ICT Foresight – How online communities can make the net work for VCS. London: NCVO	Study on the impact of ICTs on voluntary and community organisations
OECD Directorate for Science, Technology and Industry, Committee for Information, Computer and Communications Policy, Working Party on the Information Economy (2006): Participative Web: User-Created Content. DSTI/IC/IE(2006)7/Final. 12 April 2007	Working group report on drivers and tools for User Created Content

The AMS report considers three classical national-level foresight studies (China, India and Japan). Since the end of the FISTERA study, there has been only one new national foresight study launched in Europe, namely that in Luxembourg. This has not yet been completed, although the results of the first round are available.[8] ICTs are one of the six areas covered in this exercise, albeit not really in depth. Additionally, the AMS report has considered two extremely comprehensive technology scanning exercises – the DeltaScan and the SigmaScan – for the UK Foresight Programme's Horizon Scanning Centre. The "Tomorrow" project has similarly broad focus, but relies heavily on material produced elsewhere, e.g. in scientific journals or even popular science magazines.

The report by VDI-TZ[9] covers a total of eight studies focussed on national innovation systems (NIS) and ICT-related findings are one of the main topics. The report by CMI and others examines the relative scientific positions of Europe, the USA and Japan in four areas of key technologies: nanotechnologies and new materials, information society technologies, the life sciences and technologies for sustainable development.

The two US RAND reports, like those already covered by FISTERA, feed into RAND work being done for the National Intelligence Council, focused on the broader global policy

8 http://www.fnrforesight.lu/publication/phase1_summary_report_v7.pdf
9 Holtmannspötter, D., Rijkers-Defrasne, S., Glauner C., Korte, S., Zweck, A*:* Übersichtsstudie Aktuelle Technologieprognosen im internationalen Vergleich, Düsseldorf: VDI-TZ, June 2006

implications of the "Information Revolution". The 2006 volume[10] is an update of a 2001 volume conceived as a quick foresight into global technology trends in biotechnology, nanotechnology, and materials technology and their implications for information technology and the world in 2015. This was covered in FISTERA.[11]

The remaining documents are all focused on specific areas of Information Technologies (broadband access, mobile communications, wireless communications, "next generation networks) or on on-going trends recognised as likely to have significant impact on society (Web 2.0, the Internet of Things, the future of the Internet, Pervasive Computing, Nano-Bio-Info-Cogno-convergence). Two documents examined these from specific user angles, that of voluntary and community organisations and that of creative content users/producers. Finally, a report from the European branch of RAND examined the security implications of so-called disruptive technologies.

Of the foresight studies covered in the 2006 review by Holtmannspötter et al,[12] the Canadian, South African, South Korean and UK studies address application area of ICTs:

- Biometric recognition systems (Korea) and visual security techniques (the UK), which are discussed in connection with security;
- ICT supported applications in transport and logistics (Korea), which was a topic addressed by FISTERA, but which did not belong to the top priorities identified by experts;
- Substitution of travel by telepresence (Canada), which belongs to applications to enhance relationships and communication, language technologies (South Africa) and automatic translation in devices for video-conferences (South Korea) also belong to this category.
- The Chinese foresight study gives little indication about future application areas for ICT, remaining at the rather vague level of "enterprise informatization", or "informatization of society".[13]

The Indian study is strongly focused on applications in education, but with the longer-term aim of establishing India as a "superpower in knowledge"[14] or a "world-leader in the management of information of all types".[15] Particular mention is given to wholesale and retail distribution, education, audiovisual media and health services, along with, obviously, education.

As in the studies examined for FISTERA, software is rather under-exposed in the current batch of studies. This could be due to the fact that software technologies are thought to be the most unpredictable of all.[16] The 2006 RAND study, however, does address applications in the health sector, such as neural engineering and implants to help people with disabilities or ailments. Examples are auditory images for the blind and there are also expected to be devices

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[10] Silberglitt, R., Antón, P.S., Howell, D. R., Wong, A.: The Global Technology Revolution 2020, In-Depth Analyses: Bio/Nano/Materials/Information Trends, Barriers and Social Implications. Santa Monica: Rand 2006

[11] The 2001 report focuses specially on exposing the American-centric picture of the information revolution developed by previous RAND conferences to an informed European audience, and in so-doing to help deepen understanding of the course of the information revolution in Europe and elsewhere in the world.

[12] Holtmannspötter, D., Rijkers-Defrasne, S., Glauner C., Korte, S., Zweck, A (2006): Übersichtsstudie Aktuelle Technologieprognosen im internationalen Vergleich, Düsseldorf: VDI-TZ

[13] National Research Centre for Science and Technology for Development, Research Group of Technology Foresight (2005): China's Report of Technology Foresight. Beijing

[14] Gupta, S.P. (chair)(20002): India Vision 2020. New Delhi, p.24

[15] Ibid.

[16] Tomorrow Project: Glimpses at a Glance. http://www.tomorrowproject.net/pub/1__GLIMPSES/Media_and_technology/-387.html#A-387:4

to help control bodily functions (insulin monitors). Perhaps in connection with the use of such technology to enhance otherwise healthy individuals, the report expects some technology applications to trigger strong reactions over religious, environmental or social concerns. There is thus seen to be a need for a broad debate with the aim of resolving such conflicts.[17]

2.2 Main findings

2.2.1. Convergence of infrastructures

A recent primer by the US Telecommunications Association (TIA)[18] makes a useful distinction between three elements of communications networks:

1. The "Edge", which refers to the various pieces of equipment and devices used on customer premises. These are increasingly "network agnostic", meaning that the services for which they are used can now come from a variety of communication providers through Internet Protocol (IP), whereas in the past, the landscape in this area consisted of a number of "silos", e.g. voice communications as a domain of telecom companies. Homeowners are creating their own networks, serving their own specific needs. An important requisite for this is interoperability of devices and services, which is ensured by such guidelines as the "Connectivity Principles" developed by the TIA. RFID, used by industry for tracking and inventory management is also part of precondition for the "edge" as are Near Field Communications (NFC).

2. Access to Networks, which requires the removal of barriers to broadband deployment and the creation of "seamless" transitions from the elements to each other. Wireless networks can now not only be used for voice communication, but also for the transmission of data. Elements include 3G (third generation) networks, wi-fi (wireless fidelity for use in local area networks), WiMax (Worldwide Interoperability for Microwave Access, used for "last mile" connectivity at high data rates). Improvements in antenna technology are expected to increase cellular system capability, resulting in higher data rates to customers. The use of fibre instead of copper cables, e. g. fibre to the home (FTTH) is expected to provide almost infinite bandwidth. Nonetheless, copper continues to be an important element in DSL (Digital Subscriber Line) technology, which can deliver high-definition video and other high-bandwidth services. A hybrid terrestrial-satellite network is rated as a reliable option not susceptible to land disasters.

3. The Core Network, which consists of the structures and techniques enabling and guiding the flow of traffic, preferably without the customer really noticing its existence. The public internet is basically an open-ended network of in principle separate networks connected by an IP backbone running across countries and continents. Operation and intercommunications are secured by network management using routers and other equipment. Signalling determines where information is sent and how. There are also rules on handling traffic flow and on ensuring Quality of Service (QOS). Quality of service is crucial for such applications as health care and telemedicine, public safety information, Voice over Internet Protocol (VoIP), video and online gaming. A key element enabling the seamless communication of a broad variety of devices with each other and across multiple networks is the IP Multimedia System (IMS). With IMS a customer can bring virtually any device to almost any network and use the product fully.

[17] Silberglitt et al. (2006)

[18] Telecommunications Industry Association (2007): 2007 Technology and Policy Primer, Arlington Va.: TIA. http://www.tiaonline.org

In the past, the “silos” forming communications networks were each subject to their own regulations. Broadband convergence requires regulations having a consistent, equivalent and non-divisional character.

Converged infrastructures, or Next Generation Networks, create new opportunities for competition. An OECD Foresight Forum report[19] argues that regulation of such networks should focus on markets rather than the technology. The aim is to enable competition at the network and service levels. Such regulation should be “technology neutral”.

It might be necessary to review the concept of universal service if , as often happens, the technologies concerned are first applied in profitable and densely populated areas and only extended much later to commercially less viable areas.[20]

It is to be expected that broadband access to the internet which is needed to realise the visions of Web2.0, will increase rapidly to the point where access is no longer an issue. At the same time, there will be a shift from fixed cables to wireless networks, enabling the “anytime, anywhere” and “always-online” visions and also making possible the connection of remote regions in Europe and elsewhere to the Internet.

In terms of broadband subscriptions, EU territories are closing the gap to North America, but Asia/Pacific region is still ahead in terms of broadband access. Korea is the world leader, Japan and the US are strong, and the Nordic and Benelux countries are in the lead in Europe.[21]

China is one of the countries with highest growth rates for broadband access, with 13 Million broadband subscribers. Only China, the US and Japan had more than 10 million broadband subscribers in 2004, although the per capita rates obviously present a completely different picture.

There is strong broadband infrastructure competition in the US and Korea. In Europe, competition is strongest in the Netherlands, the UK and Sweden. A survey of broadband tariffs for the consumer market in Europe shows that tariffs in Sweden, Belgium, the Netherlands and France are low compared to Denmark, Spain or the UK. There is a significant span in offerings concerning maximum download speed, depending on the medium used, e.g. fibre. Short to medium range broadband solutions are growing in importance for location-based services and community services etc.

Metropolitan Area Networks as business service delivery platforms and broadband access technology are mentioned in the Chinese Foresight Study[22] as those items in the information field likely to have the greatest economic impact. Broadband access technology is also regarded as one of the technologies likely to have most impact on peoples’ lives, with new software technology in mobile computing environments close behind.

New technological developments allowing transition to wireless broadband are sometimes described as an opportunity for developing countries to “leapfrog” interim solutions needed for established industrialised countries to achieve the state of the art (see box, below):

19 OECD Foresight Forum “Next Generation Networks”: Evolution and Policy Considerations Summary Report.

20 Ibid.

21 The findings reported here are based largely on: Montagne, R. (Ed.), Causse, A., Elnegaard, N., Ryan, D., Bråten, L. E., Le Floch, L., Chira, L., Allen, S., Morozova, A., Sánchez, U.: Broadband access roadmap based on market assessment and technical-economic analysis. Brussels, December 2004

22 China’s Report of Technology Foresight (Summary) (2006)

> **Distributed and wireless technologies as an opportunity for "leapfrogging"**
>
> Distributed and wireless technologies may be an option for the rapid development of an economic infrastructure in poor, developing countries.
>
> Miniaturisation, wireless communications and embedded computation are components used to leapfrog conventional development along a path similar to that of industrialised countries. A strategy employed by Grameen telecom in Bangladesh builds on a modular, rapidly deployable cellular wireless network with shared mobile phones, linked with microcredit lending.
>
> Mobile phones are shared as a resource in owners' social networks and thus increase access by several times the number of phones.
>
> *Adapted from Stanford Institute for the Future Delta Scan "Leapfrogging" for the UK Foresight directorate.*

WiMAX at 3.5 GHz can be economically viable with existing ADSL subscription levels in rural areas with a household density in excess of 10 per km². In areas with low household densities, grants or subsidies would be required. Wireless extensions could reduce costs through sharing existing infrastructures, such as street lighting, power line posts or cellular base station locations for local repeaters and final access. WiMAX cannot compete with ADSL in areas where ADSL does not need changes in the copper infrastructure. As a fixed broadband access technology WiMAX will be mainly restricted to areas without ADSL coverage and areas or countries with poor copper networks. WiMAX can be used for nomadic data applications as an enhanced WLAN technology and eventually as a step towards mobile broadband provision, in developing countries also to provide fixed telephony services. Even in rural towns, WiMAX capacity may be limited depending on the number of subscribers. Mass production is mandatory for any low-cost solution.

Packet based networks for a range of services including voice, video and data are sometimes termed "next generation" (NGN) networks. These can be viewed as a logical evolution from separate network infrastructures to a unified network for electronic communications based on internet protocol. Characteristics are security, quality of service and easy access.[23] In NGN, operators are trying to shift up the value chain into audio-visual content.

a) Storage

Technologies for the storage of data have made rapid advances with respect to capacity and speed of access in recent years. Hard drives, even in personal computers, usually have capacities of several hundred gigabytes and the larger drives used in business applications are already measured in terms of terabytes. The projected growth of areal density is about 40% per year, so that commercially available terabyte drives should be available this or next year.[24] A recent development here is the introduction of "perpendicular recording drives", in which magnetic bits stand upright rather than lying flat on the disk, with first products launched in 2006. These should enable even greater storage capacities. Perpendicular recording involves the use of new materials, which

[23] Cf. OECD Foresight Forum "Next Generation Networks": Evolution and Policy Considerations Summary Report.

[24] Cf. Anand, V.: Seagate outlines the Future of Storage. 27 January 2006. http://www.hardwarezone.com/articles/print.php?cid=30&id=1805

have not yet proven themselves in applications, so there is some doubt with regard to the reliability of drives. Their use is being driven by the demands for digital video.

Another boost to hard-disk drives is expected from “heat assisted magnetic recording”, in which a laser heats up the area which is to be written, with another technology called “patterned media” favoured by rival manufacturers.[25] It is expected that manufacturers will eventually combine heat-assisted and patterned media to produce drives capable of storing 50 to 100 terabits of data per square inch, up to almost 600 times the density of current state of the art drives. The overall trend is towards smaller hard disk drives with higher storage capacities.[26]

Progress of this kind is needed to protect hard-disk drives from being displaced by flash memory chips in future. There have already been announcements that new generations of notebook computers will be equipped with flash drives of around 20 – 30 GB capacity.[27] These have the advantage of lower power consumption for the access to non-volatile storage media. However, Flash drives are restricted by a finite number of erase/write cycles, which creates difficulties in supporting operating systems.

An alternative to flash storage is “probe storage”, which uses 1000 heads on half a square inch and works something like a scanning microscope.[28] There are also hybrid hard disks that add Flash memory to the classic hard disk concept. These have the advantage of greater reliability and speed in booting.

Disk drives in mobile phones will most likely be only a niche phenomenon in mobile phones in the next five years. Hard drives will become more crucial as soon as 2008 and afterwards, when they will have a 5-10% share of the market. There will be demand for at least 100 million hard drives although they are unlikely to have more than a 10% penetration of the mobile market in the next 5 years.

b) Power

In particular most mobile applications depend on further progress on power technologies. Some savings can be made by replacing technologies with others that require less power, as in the example of flash memories completely or partly replacing hard disk drives. Telephones and cameras are other examples of devices embedding substantial processing power.

Options for reduction of power consumption include the reduction of energy consumed by devices, improving battery technology, the engineering of more efficient electronics and components, and by designing computer architectures and software with power as a primary measure of performance.

Beside technologies centred around batteries, much attention is been given to processes of acquiring energy from surrounding environments, known variously as “power scavenging” or “power harvesting”. Obvious examples used mainly at large scale are the wind and tides. Sunlight is frequently used at a smaller scale; think of houses equipped

[25] Cf. Kannellos, M.: A divide over the future of hard drives. 23 August 2006. http://news.com.com/2102-1008_3-6108687.html?tage=st.util.print

[26] Henrique Atzkern of Seagate, according to http://www.tomshardware.com/2006/09/14/50th_anniversary_hard_drive/

[27] At Las Vegas CES 2007, the Taiwanese Summit memory company displayed flash drives with 128 GB capacity, cf. Wikipedia article “Flash Memory”

[28] See footnote 19.

with solar panels and pieces of equipment, such as pocket calculators or sun blinds which use sunlight to recharge accumulators. Solar panels can also be integrated into clothing (so-called wearables).[29]

Smaller amounts of "ambient energy" are available virtually everywhere in the form of heat, vibration, sound and light. It is quite likely that such devices like ipods could easily be powered by movements of a wearer, such as arm movements or through devices embedded in shoes.[30] Piezo-electric material can be used quite effectively to gather vibration energy from sources such as climate control equipment, large industrial equipment, small household appliances, large exterior windows, office building floors or automobiles.[31] A "roadmap to disappearing electronics and ambient intelligence"[32] proposes a "power train" incorporating light and vibration harvesting in addition to efficient storage of harvested energy in ceramic capacitors and thin-film batteries, described as being "in the development phase". A final crucial element is to convert the voltage of the storage node into the supply needs of system components.

c) Computer architectures and programming

For many years now, there has been discussion about new computer architectures overcoming the limitations and shortcomings of silicon-based computing. Even so, silicon has remained dominant and not been seriously challenged, with "Moore's law" continuing to be valid despite forecasts to the contrary. Hafnium is being considered seriously as an alternative to silicon.[33]

In 2007, an IBM supercomputer, the Blue Gene/P, was announced. This is expected to be able to operate at a peak of 3 petaflops, or 3 $x10^{15}$ operations per second. In real world situations, it has been designed to operate at 1 petaflop. This corresponds to the performance of a 1.5 mile (2.4 kilometres) high stack of laptops. A 1 Petaflop Blue Gene/P consists of several (72) racks of servers with a total of 294,912 processors lashed together via high speed optical networks in clusters.[34] Sun has developed a high-performance computing platform, the Constellation, which has a projected peak performance of 2 petaflops.[35]

A prototype desktop computer achieving speeds up to 100 times that of current desktops was demonstrated during 2007 by researchers from the University of Maryland headed by Uzi Vishkin. It is based on parallel processing on a single chip, in the case of the prototype 64 processors mounted on a circuit board the size of a car license plate. The computer follows the same principles as existing supercomputers. In the past, it has been impossible to apply these principles to desktop computers because of severe

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29 Pearson E.: The future of fashion. BT Innovation, 7 July 2005. http://btplc.com/innovation

30 Wikipedia article „Power Harvesting", retrieved 5 April 2007

31 Rabaey, J.M.: Ultra-Low Cost and Power Communications and Computation Enables Ambient Intelligence. Proceedings Smart Object Conference, Grenoble, May 03, pp 11-13.

32 Rabaey, J., Ammer J., Otis, B., Burghardt, F., Chee, Y.H., Pletcher, N., Sheets, M., Qin, H.: Ultra-Low Power Design. The Roadmap to Disappearing Electronics and Ambient Intelligence. IEEE Circuits & Devices Magazine, July/August 2006, pp 23 - 29

33 The Tomorrow Project: Glimpases at a Glance: http://www.tomorrowproject.net/pub/1__GLIMPSES/Media_and_technology/-387.html#A-387:4

34 Kanellos, M,: New IBM supercomputer achieves teraflop. cInet News, 26 June 2007. http://news.co.com/2102-1010_3-6193211.html

35 Kanelllos, M.: Sun eyes supercomputing glory. CNET News, 27 June 2007. http://zdnetasia.com/news/hardware/0,39042972,62025136,00.htm

programming complexities. The University of Maryland team has found algorithms to use single chip parallel processing technology to overcome this difficulty.[36]

More of curiosity value are developments at the other end of the PC scale: two small PCs with 64 MB SDRAM and a 300Mhz processor, measuring about 5 cms in each direction of a cube are available from Shimafuji in Japan.[37] It is claimed that these devices, which are Linux based, fulfil all of the necessary functions of a PC. They cost in excess of €1000.

Simplification of computers has been discussed for some time already. Most PCs have features consumers hardly ever use and simplification could make computing cheaper, more reliable and virtually bug free. Software and processing capacity could be available on demand from the web, converting computing into something like a utility. This development is, however being resisted by major incumbents, like Microsoft.[38]

In the non-silicon field, the greatest hopes for progress rest on "biochemical" computing at the nanoscale and on so-called quantum computing. Both are addressed by the horizon-scanning activities for the UK Foresight directorate. Another approach to access processing power is the harnessing of computers in a "grid".

First practical biochemical nanocomputing devices are still more than a decade away, but development is fuelled by massive investment in research in genomics and nanotechnologies. DNA biological computers could offer highly parallel processing and use very little energy. Computation time is expected to be a matter of seconds, but finding the desired answer could take days. DNA computing is superior for certain purposes, but still requires human intervention to separate out correct solutions. It is unlikely to ever provide general purpose computing such as word processing.

Eventually a DNA or nanomolecular computer could be cheap and powerful, potentially capable of combinatorial optimisation, associative searching. Implications include:

- Almost unimaginable improvements in computing speed and power
- Development of an entirely new biocomputer industry
- Vast potential to develop new medicines and life forms, improvements in disease treatments, growth of crops.

An experimental DNA computer capable of 330 trillion operations per second (over 100,000 times the speed of the fastest PC) has already been built in Israel.

Major drivers are the challenges of global human health care and food production, demand for computing power, funding by governments, universities and commercial enterprises. The time horizon for this item is long: over twenty to over fifty years. While it is fairly likely, it will have medium to low impact, and it is expected to be uncontroversial. (Deltascan: The Dream of Biochemical Computing, Institute for the Future, Stanford).

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36 Maryland Professor Creates Desktop Supercomputer Prototype. CCNews, 26 June 2007. http://www.ccnmag.com/news.ph?id=5426

37 http://www.shimafuji.co.jp/product/spacecube03.html

38 The Tomorrow Project: Glimpases at a Glance: http://www.tomorrowproject.net/pub/1__GLIMPSES/Media_and_technology/-387.html#A-387:4

Working prototypes of quantum computers may be expected by 2040. Great progress is taking place worldwide e.g. at the Centre for Quantum Computing (a joint venture of the UK universities of Oxford and Cambridge). Implementation of quantum computing would make certain types of computing extremely fast. QC could enable previously impossible tasks, such as image understanding, real-time speech recognition, generation of unbreakable codes, extreme compression of data and media.

Among the implications are:

- Enhanced data security
- Decreased size of data storage devices
- Complex tasks can be performed with speed and accuracy.

The time horizon for breakthroughs is still 21 to 50 years. The development is regarded as generally uncontroversial. (Deltascan: Quantum Computing Breakthroughs, Institute for the Future, Stanford).

Another approach to enable applications requiring more processing power than most users have at their disposal is “grid” computing. Supercomputing services are expected to become available over broadband terrestrial and wireless Internet networks by 2015.

Effective supercomputing applications are currently restricted to large industries (petroleum and energy, aircraft and automotive design, pharmaceuticals). Migration to mass applications, such as media, gaming, ubiquitous computing, is expected. This has been recognised by major computer and Internet companies.

On-demand supercomputing includes grid computing, autonomic computing, adaptable computing, cluster computing, agile IT. The goal is to make supercomputing power available from a “grid” – the main building blocks so far are commodity microprocessors linked into Linux clusters. Currently, resources are underused due to bottlenecks in programming, but by 2015 it is expected that programming obstacles will have been overcome.

Applications include pervasive computing, sensor nets, speech recognition, language translation, image recognition, online games, ubiquitous media. Industrial use will include numerically modelling, high-resolution simulations, real-time interactive graphic models.

The idea of sharing computer power via networks was the original role conceived for the Internet – the idea of linking people came later. Among the implications are:

- Decreased cost and expanded availability of supercomputing
- Enhanced photo-realistic capabilities for interactive entertainment and other high-resolution media
- Potential for enhanced signal-sensing and cryptographic applications.

This development is being driven by an increasing supply of skilled programmers for massively parallel applications, and continued research into simpler massively parallel and threaded programming. It is expected that results will be visible within 3 to 10 years. The programmers required are currently in short supply, but this has been recognised.

Parallel programming is expected to become the dominant type except for small scale mobile and embedded devices. It is necessitated by a range of new computing architectures:

- Virtual computers (multiple cores on a single chip)
- Nanoscale computers (perhaps quantum computers)
- Grid or cluster computing over broadband networks

The software must provide enough concurrent operations to use all the hardware. Massive parallelism requires special programming skills and education and training of programmers seems to be a major challenge.

The implications include a need for research laboratories and software companies to develop new tools for programmers and a need for educational institutions to increase instruction for effective uses of parallel processing for application design.[39]

2.2.2 Human-computer convergence? - Technologies for direct human-computer interaction

a) Convergence of infrastructures

Perhaps the most controversial form of convergence currently being discussed is that between human-beings and machines, mainly those based heavily on ICTs. The discussion in this area has been fuelled largely by radical visions developed in connection with so-called converging or convergent technologies.

Converging technologies (CT) emerged as an issue of scientific and political discussion in the US. The term is here applied to convergence between nanotechnology, biotechnology, information technology and the cognitive sciences: Nanotechnology enables many new approaches, processes and materials at the nanoscale as well as analytical access to and theoretical understanding of fundamental chemical, physical and biological processes at the atomic and molecular levels. The implications of these trends and their synergies with information technology are described in a RAND report published in 2001.[40] On December 3-4, 2001, the National Science Foundation (NSF) and the US Department of Commerce (DoC) organized a workshop on “Convergent Technologies to Improve Human Performance“. The outcomes of this workshop and contributions submitted after that meeting were published in June 2002 in a report with the same title.[41]

The focus of the report is heavily on the use of technology to enhance human performance, starting with military applications, but also with very broad visions of societal development as a whole.

Nevertheless, funding specifically on these topics in the US is relatively small and largely confined to the activities within the context of the National Nanotechnology Initiative (NNI). Moreover, the concept of NBIC convergence originally was (and still to a large degree is) a by-product of the NSF’s and NNI’s activities on ethical, legal,

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[39] Institute for the Future, Stanford, Deltascan (2006): The Dominance of Parallel Programming.

[40] Antón et al.: The global technology revolution: bio/nano/materials trends and their synergies with information technology by 2015. Santa Monica: Rand 2001

[41] Roco, M., Bainbridge, W.S. (eds.) 2002 op. cit.

and societal implications of nanotechnology. One of its most active promoters (Roco) is one of the key architects of the NNI and senior NSF advisor on nanotechnology. According to US experts recently interviewed by ITAS,[42] the initiative itself is hardly known in the US outside of specialist circles and many of the ideas and concepts discussed in the Roco/Bainbridge book have not entered mainstream discussion.

b) The cognitive sciences as the key element in convergence?

The new, and possibly defining, element in NBIC convergence is the (re-)discovery of cognitive science: awareness of potential synergies between biotechnology, nanotechnology and information technology had already existed for some period of time before the conference. Cognitive science has a two-fold role to play in NBIC convergence, the first as an "enabler" for the necessary renaissance of (unified) science by building bridges between isolated communities, the second as a part of convergence itself by exploring fundamental processes.

There are two basic approaches to artificial intelligence which are reflected in the cognitive sciences: "one as an engineering discipline concerned with the creation of intelligent machines, the other as an empirical science concerned with computational modelling of human intelligence".[43] Other branches of the cognitive sciences, such as neuroscience, are expected to deliver the insights into the biochemical foundations of cognitive processes to enable progress in understanding human intelligence to the extent that it can be accurately analysed to be translated into functionality, and ultimately "physically" modelled with emotion-aware applications as a possible outcome.

A major question in this context is the degree of coherence between the various disciplines forming the cognitive sciences, i.e. whether results of research in one discipline or area are at all noted and then employed by the others. Experience from the beginning of the UK Cognitive Systems foresight project[44] suggests that there was, and possibly still is, a lack of awareness of possible cross-benefits of research by the various disciplines in the field.

Progress is expected from the results of research using computer-based brain scanning technologies, which enable the observation of brain activity during cognitive processes with the promise of allocating patterns of neural activity to individual cognitive processes through use of massive computing power. Opinion on the time horizons and limitations of "breakthroughs" in this area is widely divided with quite radical visions on the one hand,[45] and quite cautious assessments on the other.[46]

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42 For the DG Research SSA "CONTECS". Results from the interviews are scheduled to be published during 2007/08. The project website is at: http://www.contecs.fraunhofer.de

43 Jordan, M.I., Russell, S.: Computational Intelligence, in Wilson, R.I., Keil, F.C. (eds): The MIT Encyclopaedia of the Cognitive Sciences. Cambridge Mass.: MIT Press, 1999, pp. lxxi – xc; citation p. lxxiv

44 http://www.foresight.gov.uk/previous_projects/cognitive_systems/index.html

45 E.g. "transhumanist" visions of enhanced humans or Korea's Vision 2025 report which believes that by 2020 30% of human brain functions will be understandable. Neurocomputers modelling brain functions for logical thinking will be possible. In contrast, "synthetic biology" does not rely on the cognitive sciences, but on emergent properties of newly created biological entities, built following the principles of biotechnology and heavily involving computer science.

46 Nordmann, A.: If and Then: A Critique of Speculative Nano-Ethics. Forthcoming

c) Developments in Europe and elsewhere

In view of the radical visions contained in the Roco/Bainbridge volume and its connections with the National Science Foundation, the concept soon attracted attention at the EU level and many European countries. Beginning in 2003, the European Commission started its foresight activities in the field of Converging Technologies with the setting up of a High Level Expert Group "Foresighting the New Technology Wave" which published its final report "Converging Technologies for the European Knowledge Society" (CTEKS) in autumn 2004. The paper was immediately understood as a reaction and alternative to the U.S.-American document, broadening the scope of disciplines involved and emphasizing the role of the social sciences and humanities for future development. Another High Level Expert Group "Key Technologies" came into life from 2004 onwards, one of its tasks being to advance the concept of Converging Technologies.

The term is used in a number of reports, press releases, speeches and opinions on new and emerging technologies, but its relevance is not reflected in concrete projects that are funded by European RTD institutions. However, the concept is incorporated in research agendas for the 7th Framework Programme, e.g. in the fields of nanotechnology and information and communication technologies. Furthermore, special emphasis is put on research and perspectives of social sciences and humanities, the role of cognitive science and the identification of "converging clusters" where specific CT projects have already been funded.

In Canada, as in Europe, the NBIC concept was the subject of much interest, in this case from the foresight perspective. Convergence under the heading of "Biosystemics" was the subject of one of two studies for the Science and Technology Foresight Pilot Project (STFPP). The foresight directorate, which has since moved to the Office of the National Science Advisor at the Privy Council Office of the Government of Canada is apparently watching developments both in the US and Europe closely and has a further project "Understanding Convergence" in hand. In its latest Canadian version, convergence is called BIND, with the "D" standing for "design". Activities are, however, focused on the nano-bio combination, with some element of "info".

A recent RAND paper on the subject for the National Intelligence Council (NIC,)[47] claims that, "as RAND found in its prior study for the NIC, technology will continue to accelerate and integrate developments from multiple scientific disciplines in a 'convergence' that will have profound effects on society." Among the convergence-based "integrated technology applications (TAs)" that in RAND's view may be feasible by 2020 are new implants.

Cochlear and retina implants are the applications where most progress has currently been made, in addition to treatments for diseases such as Alzheimer's. The results achieved here could conceivably be used to "enhance" humans normally regarded as healthy, but there is not yet any widespread public discussion of this issue.

According to the DeltaScan exercise for the UK foresight directorate's horizon scanning activity, it will be possible to mediate interaction between personal electronic products by means of the human skin, resulting in convergence of electronic implants,

[47] The Global Technology Revolution 2020, In-Depth Analyses

wearables and personal area networks. While first applications will be of therapeutic nature to compensate for disabilities, there is likely to be a shift towards augmentation of otherwise "healthy" humans, e.g. optoelectronic implants designed to restore lost vision could be used to give people the ability to see outside the visible spectrum.

Korea is expected to play a leading role in the adoption of such technologies due to the popularity of plastic surgery and high broadband use.

The expected implications include:

- Therapeutic use to improve impaired hearing and vision
- Use for therapies for paralysis
- Provision of telemedicine for the elderly in smart homes
- Tracking and "body hacking" as downside.

A crucial driver is the development of sub dermal lithium-ion batteries that can be charged through magnetic induction.

The DeltaScan also expects that the first physical neural interface between a computer and a human brain will be demonstrated between 2015 and 2020. With the advent of such interfaces, humans will be able to interact directly with computers by thinking.

First successful implementations are expected at the interface between research on human perception, prosthetic engineering, medical and computer science, signal processing, molecular biology and nanotechnology.

Expected impacts include:

- Potential for the restoration or enhancement of mobility and sensory capabilities through connections to digital sensors and electromechanical and robot systems.
- Potential for direct augmentation of cognition with external computation, extension of physical capabilities with electromechanical and robotic devices.
- Potential for outside control of human behaviour through digital media.
- It is likely that breakthroughs will be achieved primarily in applications for the disabled: persons with impaired vision or hearing, amputees (military).

This development is viewed to be reasonably likely (high to medium likelihood), its impact expected to be medium to low, while it is expected to create some (medium) controversy.

d) Alternative developments for converging technologies

Focus on "human enhancement" has largely distracted attention from the "engineering discipline" aspect of the cognitive sciences to focus on aspects related to the biochemical foundations of cognitive processes with the aim of replicating and reinforcing these in humans. On the other hand, the DG Research High Level Expert Group contains three examples for "flagship research projects" which ostensibly have little to do with enhancement in the strict sense:[48]

1. Converging technologies for natural language processing – which addresses a specific European need for progress towards inner-European cohesion;

[48] Cf. Nordmann, A. (rapporteur) (2004): Converging Technologies – Shaping the Future of European Societies, p.29

2. Converging technologies for the treatment of obesity. Among the ICT related components in such a strategy are nano-tagging of food products and information technology assistants for self-monitoring of food-intake;
3. Converging technologies for intelligent dwelling. This refers to such aspects as generation and distribution of energy, waste and water treatment, where "bio-mimetic" technologies, the integration of photovoltaics in smart materials or the incorporation of environmental sensors in information and regulation systems can improve existing capabilities.

For the time being at least, this indicates that it could be more promising to pursue the "engineering" approach to convergence so that much needed applications can be developed. In many cases, these could as well be dealt with under the heading of "pervasive" or "ubiquitous" computing.

2.2.3 Pervasive or ubiquitous computing and ambient intelligence

a) The vision

"Pervasive" or "ubiquitous" computing – the terms will be used more or less interchangeably here - figures as a priority in recent foresight studies from Denmark[49], India[50] and Japan.[51] Pervasive computing has the potential to cause a paradigm shift in how societies apply and think of technology. Again, the development implies a kind of convergence, in this case between everyday objects in the human environment with ICT, although it is more usual to speak of "embedding".

In a nutshell, pervasive computing can be characterised by a number of typical features. It is:

- Small
- Embedded
- Networked
- Context sensitive
- Adaptive
- Collaborative
- Of network volume (sufficient in number and regularity of interaction to create network behaviour).

"Pervasive computing is not about a single technology, but about a potential qualitative change that may arise through an increasingly integrated technological environment".[52] Computing devices will become increasingly like instruments. Pervasive computing needs a seamless infrastructure to help people accomplish their tasks, while making devices and other technology invisible. The "infrastructure will need to be scalable, reliable and readily available".[53]

[49] As "ubiquitous computing, cf. Holtmannspötter et al. 2006.
[50] Gupta, S. P. (chair): india Vision 2020. New Delhi, Dec. 2002
[51] NISTEP: Eighth National Japanese Science and technology Foresight (2035), Tokyo, 2005."A system permitting seamless wireless communications" by 2010
[52] Kenny, L. (2006): Exploring the Business and Social Impacts of Pervasive Computing. p. 12
[53] Ibid., p.20

Pervasive computing builds on the current network and communications infrastructure, accelerating its convergence. The current network is extended to include networks based around sensors. Pervasive computing provides more input on the environment in which users operate and allows different devices to collaborate more autonomously than at present. Devices are smart and interconnected, belonging to several categories:

- Infrastructure (networks, sensors, actuators, RFID tags and readers etc.)
- Access devices (PDAs, laptops, mobile terminals)
- Embedded Intelligence (controllers in cars, washing machines etc.)
- Symbolic keys (tangible things which are convenient representations of services in the real world, e.g. credit cards as representations of payment and credit services.).

In pervasive computing, the boundaries between these categories of device will become blurred. The number of devices working "in the background" will grow. The number of mobile components per person will be in the hundreds. Devices will include objects not normally considered as communicating devices (toys, household appliances, automobiles, other machines). RFID is expected to be ubiquitous, e.g. replacing barcodes (for an example, see the next box).

Powder chips for RFID

During 2007, Hitachi Research Labs presented to the press the smallest currently existing RFID chip which measures 0.05 by 0.05 millimetres and is thus tinier than a grain of sand. Known as a "powder chip", it is thin enough to be mixed with paper pulp to add a layer of counterfeit protection to gift certificates, passports or currency. The jewellery industry is investigating embedding chips of this type in rings and necklace to track their origins and make them more difficult to sell illegally.

Each chip stores a unique 38-digit number which it transmits when stimulated by an RFID reader. The code is integrated into the chip's circuitry, making counterfeiting impossible. It is expected to be taken to the market in 2009.

Adapted from: Stemp-Morlock, G. Talking Jewelry. http://www.popsci.com/oposci/technology/8240a311ed203110vg...

There is a clear trend toward communication through several modes at the same time (voice, gestures, point and click control).

There is a need for networks without cables. There is currently still a major difference between wide area networks (WAN) and wireless local area networks (WLAN) – pervasive computing will require applications to shift from one of these types to the other and back without interruption, which is a task not fully realised up to now.[54]

Infrastructure standards are required to enable networking between services, devices etc. Pervasive computing will develop incrementally, starting from applications viewed as robust enough to deserve investment, e.g. in logistics, and then extending to more risky areas.

[54] Cf. Kenny, L. op. cit., p. 20.

A different type of network is required to aggregate data from the “edge of the network” (e.g. sensors). “The aim will be to try and filter and aggregate the data at the ‘edge’ of the network, closer to where the data is collected, leaving the servers to perform more important tasks”.[55]

Tiny processors and web servers, some as small as specks of dust, may be widely embedded in the environment and physical objects by 2015. In 2003, IBM researchers forecast that by 2007 tiny servers with a 10 GB capacity would be available for a dollar each. A demonstration of such a device took place in March 2005.

The main implications are:

- The feasibility of light and small mobile devices
- Ability to connect practically any device or appliance to a network for control.

This development is expected to take place within the next 3 to 10 years.

Pervasive computing is characterised by “self organisation” or “system equilibrium” – which stresses interconnectedness and fragile dependencies (Swirling cluster of nodes). “Critical events” may occur due to the complexity of pervasive systems and a possible move towards irreversible criticality.

Thus there is a need to increase awareness and understanding of limitations and adaptations. Electricity grids are an example of the vulnerability of complex systems: comparatively minor events can cause a system crash, as has been illustrated by recent examples in Europe.

Complex systems bear the danger of unpredictable behaviour, especially when they exhibit self-organising properties. The question arises, whether to trust complex systems capable of producing “freak events”.

Systems can have different behaviour than the sum of their parts (e.g. crowds, ant colonies). The World Wide Web is another example: it has emerged through the connection of computers using basic rules. Computer power enables researchers to understand patterns of complex behaviour and to use rules discovered in this way deliberately. This may allow the simulation and design of complex emergent systems in areas from the life sciences and economics to trading and marketing. Wikipedia is an outstanding example of an emergent system. (Ipsos Mori SigmaScan: Emergence: expect the unexpected from complex systems).

Applications of pervasive computing could lead to masses of data, which could be misused: An example is the data collected to monitor health, which would enable a “pay-per-risk” model for insurance fees, penalising certain favoured lifestyles. On the other hand, such pay-per-risk models could benefit customers for other types of insurance, e.g. accident risk, in which clients would pay a higher fee while in risky situations and a lower fee when exposed to low-risk situations. There is the possibility of lacking acceptance by consumers since such schemes require more attention.

[55] Op. cit., p. 26

Computer systems anticipating users' needs are expected to be available within the next 10 years. A range of complex automated tasks could be performed proactively if the unit were able to sense a person, application or device's context.

Examples include:

- Searching a smart calendar or itinerary for available times and destinations
- Preconfiguration of logins and identities
- Setting appointments with colleagues
- Distributing documents and meeting products.

The result is expected to be enhanced personal and group productivity.

The affinity of pervasive computing to NBIC convergence dealt with in the previous section, becomes apparent with awareness that in this area also there is a discussion on whether there is a clear cut distinction between humans and machines in pervasive systems.

In the societal area there is a virtual merger of social, working and family roles, making pervasive computing an extension of "anytime, anywhere" culture.

Mutual adaptation takes place between the technology and its users – the system models the user to be able to anticipate his or her wishes, but does this really coincide with what he/she wants?

Pervasive computing will have an impact on required skills; some old skills will become redundant with need arising for new ones.

The availability of pervasive computing interactions could have impact on social interaction with certain functions replaced by information systems. There could in principle be "digital life maps" of individuals

There might be potential for evasive technologies to disrupt the smooth flow of information and digital traces, e.g. geographical reserves where electronic devices are not allowed or technology to aggressively deny unwanted services.

Perhaps the crucial factor for the acceptance and diffusion of pervasive computing is the resolution of the privacy issue. In principle, pervasive computing applications have the potential for every piece of information linked with an individual to be "on the record". There is a strong demand for individual autonomy with regard to the control over this information and privacy, i.e. a sphere where the individual cannot be held accountable for his or her behaviour and actions. Small elements of privacy are sometimes surrendered for incentives, such as discounts in e-commerce: the customer provides the vendor with useful private information in return for lower prices. It is also possible that the concept of privacy will change due to technology, as where the technology is used to ensure security and this is perceived as desirable by a majority of citizens.

In pervasive computing everything is public until a private sphere is set up by opting out. This does not automatically imply that all records will be read or used for anything. A question is whether people will object sufficiently and bother to undertake steps against data collection by pervasive systems.

The report by Kenny assumes the maintenance of existing data protection principles:

- Individuals should be in control, give consent and be aware that data is being collected.
- The purpose and use of data must be attached to the data itself and should be verifiable over time.
- Appropriate anonymity must be maintained to ensure that a user cannot be identified.
- Systems must not link different user actions without prior consent.
- There must be agreement and specification on how long data is stored and considered relevant.

Some experts believe that an "on-the-record" environment will challenge this concept – at best it will be possible to create awareness so that choices of service can be made accordingly.

There are three basic positions on responses to the issue of pervasive computing and privacy:

1. Limited application of pervasive computing due to the need to respect individual rights and privacy.
2. There are potentially technologies to enforce data regulation. The issue is to awaken interest in the development and applications of these technologies.
3. Acceptance of the notion that privacy as of today is redundant – a new way of handling privacy must be developed.

There are suggestions to improve understanding of what should be the core of privacy and how this will actually be affected by pervasive computing. Applications of pervasive computing with obvious benefits will prepare the ground for technologies to protect existing privacy concepts and principles. A well informed public debate can help to prevent misuse.

b) Devices and displays

As noted by DeltaScan, new display technologies may enable "ubiquitous computing", where the physical location of data and processing power are no longer apparent to the user. Ubiquitous computing requires displays wherever the user might need them: in appliances, tabletops, public transport, walls etc. Types include tabletop workspaces, smart walls, chairtop work surfaces and control pads, "web signs" (digital signs that are flexibly programmable web displays for specific purposes), public display boards, floating augmented reality (personal information artefacts viewable through light head-mounted displays, possibly later direct neural connections), paper-thin digital displays, e-paper and textile displays enabled through OLEDs (Organic light-emitting diodes) and OLEPs (Organic light-emitting polymers).

Ambient displays are expected to appear in developed countries within 5 years (high-end, speciality applications). Use in consumer applications worldwide is expected in 10-20years.

Implications include:

- Enhanced personal productivity and greater efficiency at work

- Closer integration of team efforts

The state of maturity of holographic devices was demonstrated impressively through the use of a commercially available hologram projection system[56] to “teleport” former US vice-president Al Gore to the Tokyo opening of the “Live Earth” concert show. BT futurists envisage the use of this technology for telepresence, e.g. “virtual meetings”.[57]

News items in this area during 2007 included Microsoft’s “Surface”, a tabletop computer controlled by movements of the hands across a touch-screen surface, conceived for applications in hotels, stores, restaurants and public spaces. Sony demonstrated a 2.5 inch flexible OLED display, merely 0.3 mm thick and weighing 1.5 grams. Commercial applications have not yet been decided, but ideas include putting the screen up like wallpaper and incorporation in wearables.[58] Another novel item presented during the year was a portable PC with an OLED touchscreen serving as both the monitor and the keyboard.[59]

c) “The Internet of Things”

The “Internet of Things” as described in a 2005 ITU report links closely with the vision of pervasive computing. It consists of a set of new, converging technologies, which combine in a further step towards ubiquitous, pervasive computing and “ambient intelligence”. Other elements are connectivity, interactivity and context sensitivity. Smart computing and RFID (radio frequency identification) are a step towards “always on” communications. In this way, today’s Internet of data and people gives way to an Internet of networked and interconnected devices.

This requires integration of the enabling technologies:

1. Next-generation networks will be IP-based, broadband and mobile with horizontally-integrated control layers and simultaneous delivery of applications. The service related functions will be independent of transport related technologies. Ensuring network neutrality is a major concern
2. RFID is the crucial enabling technology, enabling a simple, unobtrusive and cost-effective system of item identification needed to connect everyday objects and devices to large databases and networks.
3. Sensors and “embedded intelligence” permit the detection of changes in the physical status of things, to process the resulting data and to react to them. Sensors bridge the gap between the physical and virtual worlds. Sensors are also crucial to create context-awareness.
4. Nanotechnology enables the further miniaturisation of things, e.g. processing modules and storage devices. Nanotechnology can also be used for display technologies (nano-structured polymer films) and optic cables (nano-crystalline materials), as well as for Holographones and Holo TV.

The realisation of this Internet of Things requires the active involvement of many players, including consumers, manufacturers and other industrial players. The actors include standardisation bodies, national research centres, service providers, network operators and “lead users”.

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[56] Musion Eyeliner, http://www.musion.co.uk/?gclid=CIfGlI6nro4CFQxaXgodfFgVMw
[57] BT Innovation: Telepresence – seeing is believing. www.btplc.com/Innovation/Innovation/telepresence/index.htm
[58] Daily Mail, 27 May 2007: Razor-thin TV screen you can wear as a T-shirt.
[59] Companion: The laptop from 2015. http://blog.scifi.com/tech/archives/2007/06/14/compenion_the_l.html

There is particular need for standardisation in such areas as nanotechnology and robotics, which are currently rather fragmented. Standardisation here also needs a reduction in the number of standardisation bodies involved.

As mentioned in connection with pervasive computing, privacy and data protection are major issues which have to be resolved if applications are to take off. The widespread adoption of the technologies underlying the Internet of Things requires the safeguard of principles of informed consent, data confidentiality and security. Protecting privacy should not be restricted to technical solutions, but encompass regulatory, market-based and socio-ethical considerations.

The ITU report sees the Internet of Things as a particular opportunity for developing countries, notably India and China, which both currently have substantial research programmes in the area.

2.2.4 The future of the Internet

a) The Web2.0

The other major vision for the development of the Internet is the so-called Web2.0. The emergence of user-generated content depends on new technologies that are accessible and affordable to the general public and allow for easy content production. The Internet platform itself turns out to be the basis for a wealth of new media technologies. The insight of McLuhan that all media contain other media can be applied to the Internet, which opens a creative space to shape new forms of digital media. It starts with simple HTML-editors and webpages, and leads to P2P-networks, blogs, wikis etc. The more recent tools are sometimes addressed as "web 2.0"[60] Some prominent services are listed and described briefly in the following table:

[60] Cf. Madden, M.; Fox, S. (2006): Riding the Waves of "Web 2.0". The buzzword itself however lacks a precise meaning. Most of the developments congregated under the heading had emerged before it was ever coined, so that the transition from web 1.x to web 2.0 has been evolutionary rather than a radical disruption.

Table 2 - **Some outstanding Web 2.0 services**

MySpace: a blogging platform	The company employs 300 staff, is owned by News Corporation, > 100 million accounts end of 2006, population on MySpace is currently at least 154 million and it is rising drastically with rates of about 300,000 new members per day.
YouTube: a videosharing platform	The company staffed by 67 employees has been owned by Google Inc since November 2006, 30 million U.S. viewers visited the site in January, 2007 according to ComScore Media matrix, "boasting 500.000.000 video downloads a month!"
Second Life: a virtual world gaming platform	The number of registered accounts in Second Life reached one million on October 18, and doubled, to two million, eight weeks later on December 14, 2006..The number of active users is in the region of 100,000 Second Life statistics claim that 144,108 customers spent money Second Life in December 2006.
Flickr: a photo sharing platform	Flickr is a photo sharing website and web services suite, and an online community platform, Flickr claims 5.000 page visits per minute and more than three million registered users.
Last.fm is an Internet radio station + music recommendation system	Last.fm music stock contains more than 100,000 songs; catalogue of Warner to come soon; more than 15 million active users per month (Reuters). It was sold to CBS for $280m in May 2007.[61]
Alexa: provides information on web traffic	Alexa is a subsidiary of Amazon.com, started as a toolbar. Alexa is controversial since there is dispute on the representativeness of its user base for typical Internet behaviour.
Joost: a system for distributing TV shows and other forms of video over the Web	Joost was created by Niklas Zennström and Janus Friis, the founders of Skype and Kazaa. It is based on p2p technology and has contracts with several large media companies, e.g. Viacom and Warner bros. Previously described as "cable TV without the need for a set-top box", it is now being marketed as a piece of software that can reside on a variety of platforms – including set-top boxes.

Source: Data compiled from Wikipedia, when not indicated otherwise.

A recent report by the "Foresight Company" Z-Punkt has collected information on Web2.0 developments and their implications for business, first and foremost from the viewpoint of applications. Web2.0 involves users and empowers them, services can be personalised and it is possible to implement "viral" marketing, drawing on the idea that people will pass on and share interesting and entertaining content. Web2.0 is perceived as offering new job opportunities, in particular for a new breed of software developers and users in the value chain have the opportunity to actually earn money from their involvement.

[61] Williams, C.: Last.fm scobbled for $280m. The Register, 30 May 2007. http://www..theregister.co.uk/2007/05/30/cbs_last_fm/print.html. Accessed 31 May 2007

Web2.0 represents a threat to incumbent industrial players and for centrally controlled data processing units in companies. There are also data protection and privacy issues which need to be resolved.

Web 2.0 implies a further step in the commercialisation of the Internet, as users will be more and more involved in the value chain. In the midterm, users or customers will expect remuneration for their contributions and efforts.

Social commerce involving customers can take many forms, e.g.:

- e-commerce platforms where end-users offer goods themselves,
- E-commerce platforms personalising and filtering by means of user input (click streams, social tagging, recommendations etc.)
- Decentralized e-commerce combining self-expression and users' content with advertising (where end-user get a share).Context sensitive ads are considered one of the pivotal innovations in advertising.[62]

The vision "the net is the computer" is reinforced with a notable impact on work-life in general, and online co-operation (joint editing, project management, p2p-environments) in particular.

There is an interesting trend that ICT-developments for non professional end-users are driving and challenging IT-departments in businesses. Where incumbent IT-departments are centralised, bureaucratic and inflexible, users may start bypassing them going for web 2.0 services (e.g. enterprise wikis or webtop services).

Simple jobs or tasks (information work) can be offered by a company or an agency worldwide and income for unskilled workers can be generated directly (e.g. Amazon Mechanical Turk rendering “return on contribution“).

In the long run the ongoing virtualisation (e.g. Second Life) is important for new services, e.g. for the provision of consultation services (e.g. travel agencies).

The Web will serve as a new kind of operating system allowing to build on it applications and services based on APIs (application programming interfaces), new programming tools (e.g. Ajax) aiming to personalise content streams and mashing up content streams from different sources (e.g. city maps and location of members of special interest groups).

A well known paradigm of co-operation is open source software development. Web 2.0 in combination with the APIs of Web-Platform providers allows for the creation of new Web2.0 services programmed by a new kind of software developers. Today there are an estimated 1.600 Web 2.0 services.

A particularly powerful vision is the mobile Internet combined with context sensitive services. Broadband mobile Internet will create opportunities for new context sensitive

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[62] Schroll, W.; Rodenhäuser, B.; Neef, A. (2007): Mash Up Your Business. Der Web 2.0 Report. Z_Punkt: Essen, Karlsruhe, Berlin, p. 52

services and imply a "renaissance of place".[63] This will be a new dimension of ambient intelligence, location based services, and ubiquitous computing.[64]

Another vision is "desktop manufacturing" or "user manufacturing". In the first case three dimensional objects are produced at the user's 3d-printer, in the second case users convey their (computer aided) design of objects to manufacturers.

b) Beyond Web 2.0

Even though the transition to Web 2.0 has not been completed, there is already much talk of Web 3.0, Web 4.0 and even further versions of the web. These visions should not be taken too seriously for the moment, since the further development of the web is likely to be incremental rather than abrupt. Even so, some features of the next generation, or Web 3.0, are already largely visible.

Web 3.0 is what is also called the “Semantic Web”, the main idea behind the vision being to enrich the data on the web with metadata conveying its meaning. Web 3.0 is expected to consist of three distinct layers:

- A **foundation layer,** consisting of Application programming interface (API) services. These “powered” the Web 2.0 and are likely to be the engines driving Web 3.0, like Google search, AdWords APIS, Amazon affiliate APIS, RSS feeds etc. The Web 3.0 is expected to squeeze out the profit margins in API services.
- The **middle layer** will be formed by aggregation services, i.e. intermediaries bundling the API services. Examples are the various RSS aggregators and emerging web services marketplaces like StrikeIron.[65] Here, “the Marketplace is built on top of a technology platform that provides a consistent interface across many XML-based Web services from multiple, diverse sources. This allows customers and partners to customize and integrate external data sources and additional external functionality into enterprise, Web, and composite applications”.[66]
- The **top layer** consists of application services and it is here that most money will be made. The services will be composite applications bringing together functionality from multiple sources to help users achieve their objectives flexibly and intuitively.[67]

There is an additional “half layer” consisting of serviced clients, which users expect to be maintained and managed on their behalf.

While Amazon, Google and eBay will still be active in Web 3.0, additional new actors are likely to be important. Table 3 is an overview of some likely major players in Web 3.0.

[63] Op. cit. p. 26
[64] Op. cit., p. 30
[65] http://www.strikeiron.com/
[66] http://www.strikeiron.com/company/default.aspx
[67] Wainewright, P.: What to Expect from Web 3.0. http://blogs.zdnet.com/SAAS/?p=68

Table 3 - Web3.0 or the Internet as a platform for third party services

Company	Services
WebEx	On-demand collaboration, online meeting, web conferencing and video conferencing applications
WebSideStory	Markets web analytics services.
NetSuite	Software as a Service (SaaS) for small to medium enterprises.
Jamcracker	Security-as-a-Service, i.e. delivering traditional security applications as an Internet-based service, on-demand, to consumers and businesses.
Rearden Commerce	Online tool that helps people find and purchase the services they need, e.g. travel planning, dining reservations, package shipping, web conferencing, event tickets, and more.
Salesforce.com	On-demand Customer Relationship Management (CRM) solutions.

Sources: list from Wainewright (see footnote), descriptions from Wikipedia and/or websites of companies concerned.

Web 3.0 will not be restricted to shopping, entertainment and search, but will also include business applications on the same on-demand architecture as consumer applications.

The development of Web 3.0 is expected to improve revenue techniques measuring and pricing on-demand functionality. There is thus a need for an infrastructure for presenting bills, collecting payments and distributing proceeds.

c) Long-range visions of the Internet

Web 3.0 is expected to be developed during the decade from 2010 to 2020, when it will be succeeded by a Web 4.0. In a vision currently being discussed,[68] Web 4.0 is equated with WebOS and linked strongly with Ray Kurzweil's vision of the "singularity", which also plays a role in NBIC convergence. Kurzweil feels that the Web 4.0 will be equivalent or superior to, the human brain by 2029:

"By 2029, sufficient computation to simulate the entire human brain, which I estimate at about 1016 (10 million billion) calculations per second (cps), will cost about a dollar. By that time, intelligent machines will combine the subtle and supple skills that humans now excel in (essentially our powers of pattern recognition) with ways in which machines are already superior, such as remembering trillions of facts accurately, searching quickly through vast databases, and downloading skills and knowledge."[69]

The achievability of this vision and its implications are obviously still the subject of controversial debate.

68 Farber, D.: From Semantic Web (3.0) to the WebOS (4.0). Between the lines: http://blogs.zdnet.com/BTL/?p=4499

69 http://www.kurzweilai.net/meme/frame.html?main=memelist.html?m=1%23691

On the more general level, a project by Elon University and the "Pew Internet project" is trying to look forward at the internet in the next 150 years. This is complemented by a look back by 150 years. The report picks out major trends expected for time horizons extending from 2010 to 2150, describing 4 to 5 items for each time period and listing "other possibilities" from a list compiled by Ian Neild and Ian Pearson for a British Telecom Technology timeline. It links with work done on the telephone in the 1980s by Ithiel de Sola Poole.[70]

- By 2010 the NSF is expected to fund a project for the redesign of the Internet called the Global Environment for Networking Investigations (GENI). This will focus on security as its main concern, be able to cope with the increased volume of traffic and also be geared to handling content-delivery for more video and other large-scale projects. According to NSF GENI will "enable the vision of pervasive computing and bridge the gap between the physical and virtual worlds by including mobile, wireless and sensor networks." RFID and GPS will be widespread by 2010 and there will be interactive guidebooks for educational use by tourists.
- There are predictions that computers will surpass the intelligence capacity of humans around 2010.

Predictions for the period until 2014 include:

- There will be video tattoos.
- Viewers will be able to pick arbitrary angles or player views to watch sports events.
- Spectator experience at sports grounds will be enhanced with augmented reality.
- There will be immersive VR shopping booths.
- 60 percent of internet access will be from mobile devices.
- TV quality video screens will be built into clothing, with laws restricting what can be shown on TV clothing.
- There will be a portable translation device for simple conversation.

The report includes a list of further predictions, the technological basis of which is not always entirely clear.

By 2015, it is anticipated that teleportation as known ´from science-fiction, will be developing on the basis of nanotechnology. That year is also expected to see the evolution of smart, adaptable materials. Among the other items forecasted for 2015 are the following:

- 25% of all TV celebrities will be synthetic, and the highest paid celebrity will also be synthetic.
- There will be self-aware machine intelligence.
- There will be computer-enhanced dreaming and robot dance tutors.
- Virtual reality scenes will be used as décor in household rooms.
- Academic learning is argued to be unnecessary in the age of smart machines.
- Electronic stimulation of brain sensation is a recreational substitute for drugs.

[70] de Sola Poole, I. (1983): Forecasting the Telephone: A Retrospective Technology Assessment.

By 2020, there are expected to be immersive virtual reality worlds for socialising, entertainment and business. At that time robots will become ubiquitous, taking over many physical jobs and are expected to be granted their own set of rights by 2020. Ian Pearson expects robots to be fully conscious with superhuman levels of intelligence by this time, which seems to be another example of "if and then" thinking. An open question is whether human intelligence will expand to keep pace through enhancement (downloads, implants) with the robots or be left behind.

By 2025, there will be holographic television.

The resources go well beyond the time frame of EPIS06 with predictions such as "singularity" taking place some time after 2045 or extensive use of virtual reality in retirement homes.

As an adjunct to this exercise, the Pew Internet and American Life project conducted a large-scale survey on the effect of the internet on social, political and economic life in the year 2020. 742 responses were received from internet leaders, activists, builders and commentators.

There is agreement on how technology might evolve, but less agreement on the impact of this evolution. A global low-cost network is expected be in place and thriving in 2020. There were some who said that resistance to change would come from business eager to preserve current advantages. There was also disagreement whether the world would "flatten" due to technology, i.e. whether there would be fewer digital divides.

Most respondents feel that humans will still be in control of technology, but some fear that machines and processes beyond human control could be created. There is less agreement on privacy issues, i.e. whether the benefits of greater transparency will outweigh the loss of privacy.

There will be compelling and addictive virtual worlds which can on the one hand foster productivity and creativity, but lead to addiction problems on the other.

A majority felt that English would remain the most important language for the internet, but others maintained that Mandarin and other languages would expand their influence. The biggest tasks were to build network capacity and to diffuse knowledge about technology.

To summarise, while the timeline includes many rather bold predictions including the realisation of artificial intelligence to humans within a medium time-frame, the experts giving their opinion on how the internet would evolve were rather less spectacular in their views.

- While they thought it likely that there would be a global low-cost network in place and thriving, there were those who thought that there would still be some economically–motivated resistance to its use.
- Opinions on whether the Internet would help overcome divides were themselves divided.
- Although there were voices who thought that machines and processes beyond the control of humans were likely, most respondents still felt that humans would be in control.

- Virtual worlds had the possible benefit of enhancing creativity, but also held the danger of addiction.

2.2.5 Citizens' concerns

a) Privacy, data protection and trust

Privacy and trust have been a crucial factor in applications of ICTs, most visibly since PCs, Internet access and mobile telephony have become commonplace. Over all, complex social and economic concerns, of which trust, risk and privacy are topmost examples, are issues which must be dealt with if "disruptive technologies" are to make a breakthrough.[71]

Of the recent "Asian" foresight studies, only the Eighth Japanese Foresight Study addresses privacy in any way. One of the most important ICT related topics in the entire study is "A highly reliable network system capable of protecting the privacy and security of individuals and groups from intrusion by malicious hackers".

Privacy is an important issue in the joint IBM/Swiss Re/TA Swiss paper on pervasive computing already discussed at length in this AMS report.[72] This report was produced in Europe and non-European countries' perceptions of Europe are that privacy is – perhaps unnecessarily – an item higher on the agenda than elsewhere. A 2001 RAND report focused on Europe[73] finds that European and US viewpoints on privacy differ and that there is a need to adopt common standards. While Europe needs to trust US-built information systems, it also perceives itself as being dependent on these with the suspicion that "back doors" have been built in to allow the US government or commercial undertakings to collect intelligence to be used in global competition.

Nonetheless, European experts also find that security-awareness among users is limited, that there is a perceived conflict between policing of ICT traffic to prevent abuse of ICT systems, and the desire for privacy. Data protection is viewed as a potentially "essential legal requirement".

Among the technical artefacts becoming commonplace and posing a threat to current notions of privacy are small digital cameras embedded in such everyday objects as cameras and badges, and GPS systems, which pose a threat to privacy and anonymity, particularly through their ability to track individuals.[74] This use is being discussed in connection with the use of RFID chips by parents to track their young children.[75] Not unexpectedly, this is controversial. Since convergence of technologies and functionalities are thought likely to be a continuing trend, data security and privacy are considered to be an important issue, with a need to regulate previously separated functions. The use of cameras in public places, such as gymnasiums or courtrooms is singled out as an example.

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71 Cf. Robinson, N., Ortiz, D., Ligtvoet, A., Botterman, M., Valeri, L., Shoob, R., Nason, E. (2006): Security Challenges to the Use and Deployment of Disruptive Technologies. Cambridge: Rand Europe, TR-406-EC, Final Report (D4) 29 September 2006

72 Kenny, L. (2006): Exploring the Business and Social Impacts of Pervasive Computing.

73 Hundley et al. (2001): The Future of the Information revolution in Europe.

74 Silbergliitt, R. et al. (2006): the Global Technology Revolution 2020. In-Depth Analyses: Bio/Nano/Materials/Information Trends, Barriers and Social Implications. Santa Monica: RAND.

75 The Tomorrow Project: Glimpases at a Glance: http://www.tomorrowproject.net/pub/1__GLIMPSES/Media_and_technology/-387.html#A-387:4

Regulation problems due to new technology – an example

Filming of certain sport events is prohibited to prevent copying of elements or the whole of "programmes" which form the basis for judging competitions. With the integration of movie camera functions in conventional photo cameras or mobile phones and thanks to advances in flash memory technology, it is now practically impossible to detect whether an individual is taking a photo of the event, which is allowed, or filming a programme performance, which is prohibited.

The RAND report, which is not in this case especially focused on Europe and European privacy concerns, states that there is an increased interest of researchers on ways to protect and assure privacy: "With the right set of research and/or regulatory incentives, IT researchers and developers can create technology that embraces cultural norms and preferences for privacy and/or anonymity".[76]

According to the previously quoted IBM/Swiss Re/TA Swiss report on pervasive computing[77] "an on-the-record environment" as created by pervasive or ubiquitous computing could challenge existing concepts of privacy, so that there is a need to foster awareness of issues in this area for consumers to be able to make informed choices on what aspects of privacy they might be prepared to surrender for benefits provided by the services.

The second most important priority for the Internet, according to experts interviewed for the PEW Internet II project, was the creation of a "legal and operating environment that allows people to use the Internet the way they want, using the software they want".[78]

Privacy, then, is a sensitive area, embracing solutions in both the technical and non-technical (regulatory) spheres. In certain circumstances, failure to give significant attention to privacy issues can prove an important barrier to the acceptance of ICT applications. Regardless of varying degrees of importance attached to such privacy issues across the world, it would seem that developers are increasingly aware of this aspect.

b) Security and robustness

Whereas privacy is not an urgent agenda throughout the world – one need only think of China, for example, security of IT systems and infrastructures is a global concern.

- The Chinese foresight study particularly highlights technologies for the safety of information and the safety of networks.[79] In fact the two items of uttermost importance according to the Chinese Delphi study were "information security" technology and "network security technology".
- Three of the five most important ICT related items in the Eighth Japanese Foresight Study are also related to security: highly reliable network systems, technology to detect intrusions and viruses on the Internet backbone, and capability to trace back the source address of suspect packets on the Internet to

76 Op. cit, p. 186
77 Kenny, L. (2006), op. cit.
78 Anderson, J.Q., Rainie, L. (2006): The Future of the Internet II. PEW Internet and American Life Project.
79 This is highlighted as an outstanding finding of the Chinese Foresight study by Holtmannspötter et al. (2006)

detect intrusions. The report itself states: “This can be seen as reflecting society’s current anxiety and social demand for greater safety”.[80]

- In a different vein, the report on pervasive computing spells out the risk of unpredictable behaviour as a result of self-organisation of complex systems, which could lead in extreme cases to “freak events”.

The FISTERA final report, building on the FISTERA on-line Delphi and expert workshops, found that security, as an application area of ICT, on the other hand had been temporarily overrated as a result of terrorist activities at the beginning of the new Millennium. While this might well be the case, recent foresight studies mention ICT applications related to security as priority items for research and development:

- A South Korean study covered by Holtmannspötter et al. (2006) mentions biometric recognition systems to automatically and unobtrusively identify persons thought to be available by 2012, the UK study covered in the same overview mentions trust in cyberspace and visual security techniques as important, while a US study particularly highlights sensor systems for protection against terrorist attacks with bio-weapons.
- The 2006 RAND report highlights the use of biometrics across a broad range of applications, including the Internet and e-commerce, law enforcement, ID documents, PC access or voter registration.
- According to the Outsights - Ipsos MORI Sigma Scan, the introduction of measures and technologies for increased mass surveillance is being favoured by current public concerns over security and terror threats. Technology includes cameras and CCTV, loyalty cards, information captured through behaviour on the Internet and biometric ID cards. Use and sharing of information is giving rise to data protection and privacy concerns and the actual impact on crime rates is controversial.[81]
- A second Outsights-Ipsos MORI item argues for the merger of technological and human approaches to security: Detection, identification and surveillance are the most import technologies underpinning understanding of crime and security in a complex, networked world. Many of the existing threats have been complicated by increased international mobility: hence the use of scanners and sensors for detection and biometrics for identification. Potentially agent-based searching can be used to identify suspicious e-mails. This is an area of great controversy.[82]
- A further Outsights - Ipsos MORI article notes that Chinese researchers have shown that the standard SHA-1 algorithm which forms the basis for much computer security is vulnerable to attack. New computers built on novel architectures will enable new mechanisms (e.g. quantum cryptography).[83]
- The PEW Future of the Internet II report expects that Luddites or what it terms as “refuseniks” will commit terror acts against the Internet. Thus an important priority was the development and arming of an effective international security watchdog association.[84]

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80 NISTEP (2005) op cit., p. 95
81 Outsights- Ipsos MORI (2006): Who’s Looking At you? Increasing Mass Surveillance.
82 Outsights- Ipsos MORI (2006): Security: marrying technological and human approaches.
83 Outsights- Ipsos MORI (2006): The quest for unbreakable code.
84 Anderson, J.Q., Rainie, L. (2006): The Future of the Internet II. PEW Internet and American Life Project.

- The Eighth Japanese Delphi study identifies ICT applications aimed at assuring security in other spheres of life as particularly important: technology to ensure safety of human life from earthquakes or the application of advanced modelling and simulation techniques to predict diseases and disasters.
- The European RAND report on disruptive technologies[85] notes that what are currently "disruptive" technologies are key elements of the future (European) information infrastructure, which makes existing security concerns an urgent priority.

At the level of the individual firm, there were growing concerns that employees were taking matters of computer security too lightly: passwords are kept on post-it notes and over a third of IT professionals claim that they could still access their companies' networks after they had left their jobs.[86]

Overall, the security problems of "next generation networks" are expected to be much the same as those already existing for the Internet. The positive aspect of this finding is that there is already work going on to find solutions, but on the other hand, the problems are also multiplying.[87] However, as the RAND report notes, too "heavy" policies at too early a stage could well hamper developments, which are generally spontaneous and "bottom up".[88]

c) The digital divide

Like security, the digital divide has at least two dimensions, when discussed in connection with ICT:

1. The technical dimension, meaning access to digital technology and infrastructure, such as ICT devices and the Internet.
2. The socio-economic dimension, which consists largely of education and training aspects as well as affordability of the technological devices and infrastructure needed to participate in an "information" or "knowledge society".

The Canadian Foresight Study covered by Holtmannspötter et al. (2006)[89] actually foresees a basic right of access to the information infrastructure, the South African study covered in the same report particularly addresses mobile technologies and devices which are of importance to countries with less developed fixed infrastructures and less densely populated, so that creating an appropriate fixed infrastructure would be prohibitively expensive.

A specific kind of potential digital divide is that created by age. While there are still older citizens of the EU and other industrial countries, who are not used to working with computers or using them for other purposes, this is a problem likely to disappear as time progresses. However, due to ageing of populations worldwide, there are calls

[85] Robinson, N., Ortiz, D., Ligtvoet, A., Botterman, M., Valeri, L., Shoob, R., Nason, E. (2006): Security Challenges to the Use and Deployment of Disruptive Technologies. Cambridge: Rand Europe, TR-406-EC, Final Report (D4) 29 September 2006

[86] Errity, S.: Firms urged to tighten up access policies. The Register, 30 May 2007. http://www.theregister.co.uk/2007/05/30/corporate_security_surve...

[87] Cf. OECD Foresight Forum "Next Generation Networks": Evolution and Policy Considerations Summary Report.

[88] Robinson et al., op.cit.

[89] Also treated as a case study in FISTERA.

to give special attention to the needs of the elderly when designing technology, e.g. to take account of physical abilities or visual capacity.

There are three categories of technology for the elderly:

- technology accessible for the elderly
- technology to improve the quality of life
- technologies to hold back ageing.

Increasing demand from elderly consumers will lead to redesign of user interfaces, e.g. the introduction of speech recognition and haptic interfaces.[90]

The Indian study sees telecommunications as a springboard for the development of the country into an information society and knowledge economy. A major challenge for India is investment in telecommunications infrastructure. ICT use is anticipated to enable India to leapfrog into a predominantly service economy by 2020. In particular there are hopes that by these means it will be possible to generate employment covering the "large unorganised segment of the economy, rais(ing) incomes and increas(ing) purchasing power".[91] At present "India's tele-density remains appallingly low".[92] Among the nine "Nodal Points for Indian Prosperity" outlined as recommendations at the end of the report is the continuous expansion of the physical infrastructure for raid low-cost transportation and communication and the application of computers to improve access to knowledge and information, and increase in the speed, efficiency and convenience of activities in all fields of life.

Furthermore, the Indian study addresses the need for a comprehensive strategy to enhance India's employable skills. This involves television and computerised training. Recommendations include the creation of a network of 50,000 computerised vocational training centres run as private, self-employed businesses, similar to STD (Subscribers Trunk Dialling) booths or Internet cafés, to deliver high-quality, low-cost training to 10 million workers per year. This would be five times the present number, meaning that ICT methods are viewed as having the potential to increase productivity in this area by 500 percent. By 2020, computerisation of education is expected to dramatically improve the quality of instruction and the pace of learning, so that many students will complete the first twelve years of school curriculum in eight."[93]

The Eighth Japanese Foresight study does not identify any particular need for Japan to close "digital gaps", but the provision of a system permitting seamless wireless communications is on the agenda for the ongoing decade.

Among the differences between Europe and the US pinpointed in the 2001 RAND comparison is a European desire for convergence among the countries of Europe: the US simply wishes to "get ahead". The BROADWAN project[94] is actually concerned with the development of a strategy to provide broadband services for all citizens in Europe within a period of ten years from 2004.

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90 Outsights-Ipsos MORI Sigma Scan: Technology for a greying population.
91 Gupta, S.P (Chair)(2002): India Vision 2020. New Delhi. P.22.
92 Op. cit., p. 63
93 Op. cit., p. 93
94 Montagne, R. (ed), 2004, op. cit.

The greatest concern about closing both kinds of digital gaps understandably is shown in the Indian Foresight study. The other studies focus almost exclusively on the aspect of infrastructure. This should probably not be interpreted as indicating that there is no need for measures for computer/Internet literacy or a lack of awareness of such a need, but rather that measures are already in place.

The section of the Tomorrow Project's Glimpses at a Glance website, in its "implications" section notes that the notion of digital divides is elastic and that as one divide disappears, another will emerge:[95] "access to and use of media technologies will reflect the general rich-poor divide within society".

d) Intellectual property rights

An essential issue for the creative sector, which was at the centre of EPIS' attention for 2006/7, is framing and managing *intellectual property rights* (IPR). Regarding the emergence of and transition to a creative digital content sector, a series of outstanding problems have to be solved. A study on "interactive content and convergence" commissioned by DG Information Society and Media has identified "piracy" and "legal and regulatory issues" as challenges today, which will not fade away easily neither short term (2008) nor mid-term (2010).[96] Following the study, "piracy" is foremost a threat for movie and music industries, followed by TV and games, publishing and finally radio. Regulatory issues are regarded as more pressing for TV, games and publishing, and less for movies, and even less for music and radio.[97]

The ease of copying digital content and distributing it through global networks without significant costs doubtless implies an increased risk of copyright infringement. According to data of music industry lobbyist IFPI (the International Federation of the Phonographic Industry), the global music sector suffered € 3.8 billion losses from all forms of piracy in 2005, i.e. more than 15% of worldwide sales of € 26.9 billion.[98] In the view of IFPI "[E]xperience suggests the problem of illegal filesharing on the Internet can be contained by a range of different strategies, but will not be eliminated".[99] In other words: the "darknet" – a term coined by Microsoft engineers - will persist.[100]

One of the obvious measures to contain "piracy" that IFPI was thinking of, is of course DRM – Digital Rights Management. From the perspective of the creative content sector the question is, whether DRM is an enabler or a barrier to innovation and growth of creative content. In any case DRM is the bone of contention in a multi-party battlefield.

Not only do the interests of creative artists, creative users and consumers often differ from those of major labels: even within the music industry independent labels have other interests than the major labels, and even within major media companies different approaches are followed.

95 The Tomorrow Project: Glimpses at a Glance: http://www.tomorrowproject.net/ /pub/1__GLIMPSES/Media_and_technology/-1249.html
96 Screen Digest et al. (2006): Interactive content and convergence: Implications for the information society, p. 300.
97 Cf. Screen Digest et al. (2006), p. 301:
98 IFPI (2007): IFPI:07. Digital music report.
99 IFPI (2007), p. 18
100 Biddle, P. et al. (2002): The Darknet and the future of content distribution.

Consumers are certainly not fond of protected content. If content-protection leads to restrictive conditions of use and thus to a negative balance of value considerations, then the consumer may not even find it unethical to opt for P2P filesharing.[101] DRM systems are often at odds with established rights and through this harm consumers and citizens, and decrease trust in B2C relations.[102] The lack of acceptability of protected digital content is a notable setback to the success of creative industries in the digital environment.

Beyond the actual hassle due to shortcomings of the technology the content sector has to learn that the "consumption of content – and particularly that of music – is something very social, which results in the demand for sharing and recommending features"[103], and even more as Lilley has pointed out hinting at the creative user: mixing and modding "are creative acts …, although they are sometimes acts designed more for self-expression or as elements in a cultural conversation within a small group than as mass market entertainment products".[104]

DRM – What is acceptable for consumers?

Data from a recent survey by TU Darmstadt/Spiegel Online of 11.000 German consumers shows that not more than 7% of the sample would be willing to pay 99 Euro Cents for a DRM-protected music file, while 82,3 would be willing to pay 99 Cents for the same file in unprotected form. 60 percent still said they would accept a track with a digital watermark.[105] This is in line with the findings of the INDICARE survey. Online-music users were asked whether they' would prefer a song that you can copy once and burn 3 times for 50 cents or a song you can do everything with for 1 Euro. 63 % preferred the more expensive but unprotected file, 37% the cheaper protected one. They were also asked if they'd prefer a watermarked song for 50 Cents to an unprotected one for 1 €. 57% preferred the unrestricted one, but nevertheless 43% would prefer the cheaper watermarked one.[106] Given the widespread availability of music without DRM in file-sharing services, the high degree of willingness to pay for watermarked and non-protected content sounds encouraging.

The question whether the music industry can prosper without DRM has reached the industry: Rob Glaser, the chief executive of RealNetworks which runs the Rhapsody subscription service said that in fact DRM might be abandoned: "It will happen between next year and five years from now, but it is more likely to be in one to two years".[107] In addition, Steve Jobs, the CEO of the most successful music-platform for DRM-protected content, iTunes, started a roll back strategy arguing that once implementing DRM was the condition of the major labels to license their content to iTunes. Today media companies should reconsider the use of DRM, because in sum "… DRMs haven't worked, and may never work, to halt music piracy".[108] Independent labels and consumer organisations applauded as expected. Meanwhile EMI is

[101] Institute for Information Law – IVIR (2006), chapter 6.
[102] An empirical study and risk assessment revealing the privacy deficits of DRM solutions in the market is presented by Bizer, J. et al. (2005): Privacy4DRM
[103] This is also a result of a European consumer survey; see INDICARE 2005, p. 31.
[104] Lilley, A. (2006): Inside the Creative Industries, p.5.
[105] Results quoted in: Online Musikmarkt (8.2.2007): Studie belegt: Konsumenten lehnen DRM ab.
[106] INDICARE (2005a), p. 26, 29.
[107] Shannon, V. (2007): Record labels mull unrestricted digital music
[108] Jobs, S. (2007): Thoughts on music.

delivering non-DRM-protected files via the iTunes platform, and a second major company, Universal, has also announced experiments from August 2007 on with DRM-free music on several platforms, but not on i-Tunes.[109]

Attractive business models for digital content do not necessarily have to rely on DRM (alone). One strategy is to turn to indirect revenue streams by advertising, to position digital content as a promotional tool and to rely e.g. on income from ticket sales for live concerts, merchandising, and sales of CDs. A third strategy is to offer copyrighted content for free as a promotional mechanism for paid content.

Caution and clarity however are needed to avoid confusion. There are forms of "good" DRM, which are probably indispensable and highly important for creative content markets. In the B2B segment, effective DRM systems are an indispensable prerequisite for content producers allowing them to clear rights before creating new content.[110] Following the assessment of Screen Design: "'Circulation of content rights' is one of the biggest problems today… However, we believe… that this particular issue will largely be solved by market players through new business and legal practices over time, so that the issue will not be in the top 3 most acute obstacles within two years."[111] Since restrictive DRM technologies have often failed to facilitate viable business models for digital content in the B2C segment, there is a search for unobtrusive, convenient, reasonably priced services with modest and acceptable restrictions imposed by DRM system.

What we observe in digital content markets is a shift from DRM-technology as "containment" of content to "forensic DRM", i.e. methods to mark, track, and trace the content and/or the owner of the content.

Examples of forensic DRM

Acoustic fingerprinting (perceptual hashing technology) is one prominent technology of this kind. It can e.g. analyze the bits of a music track and identify it. For each file, the network software looks up the fingerprint in a database and determines what the track's copyright owner wishes to do about controlling access or charging the user. Now there are two services in the US market that use acoustic fingerprinting with licensed content from major labels: Mashboxx and iMesh. MySpace announced the use of acoustic fingerprinting technology to ensure that users do not upload copyrighted music to their MySpace pages.

Another prominent technology is called *transactional watermarking* (fingerprint watermarking) embedding the identity of the user into a downloaded file. Apple is likely to use fingerprint watermarking for its film and television downloads. In Germany, H2 Media Factory launched a download site for PCs called Akuma, which features music from independent labels and uses fingerprint watermarking technology from the Fraunhofer research labs. Bill Rosenblatt's 2006 review on DRM technologies[112] expects that 2007 will be a year of significant developments on both watermarking and perceptual hashing fronts. "The ways in which these technologies will coexist (or not) with 'classic' encryption-based DRM are unclear now and should be fodder for innovation in the coming year".[113]

[109] Cf. Rosenblatt, B. Universal to start DRM-free experiments. DRM Watch, 10 August 2007
[110] See the overview of European DRM initiatives in INDICARE (2004), pp.6-18.
[111] Screen Digest et al. (2006), p. 267; cf. also p. 275 and p. 280 where collective management of rights is addressed.
[112] Rosenblatt, B. (2006): 2006 Year in Review: DRM Technologies.
[113] Rosenblatt, B. (2006), ibid.

Another field of DRM research deserving more attention are DRM systems able to respect the exemptions from copyright stipulated in copyright law (private copy, exemptions for education, science, libraries etc.) (cf. Armstrong.[114]) Overall a thorough analysis of DRM research and DRM-industries understood as an enabling technology for digital content business models is recommended. This analysis would have to include a patent analysis as well as an analysis of standardisation efforts (including open standards) in this field.

EITO ventures to develop a long term view with an important message for the creative content sector considering the potential of p2p and IM (instant messaging) – for details see the box below.

A long-term view: integrating content and communication

The desire to communicate is fuelling the steady addition of new features to once exclusively voice-based services. Text, photos, music and video, all IP-based, are being incorporated into the communication process on both fixed and mobile platforms. In the long term (ten to 20 years), advanced multimedia IM could be the future of file sharing, with P2P software integrated with IM devices and solutions.

A further step would involve the ability to share live music and video with a community of peers. This would require a substantial rise in the bandwidth available for file uploads, and possibly the deployment of new FTTx networks.

For the consumer, this live and instantaneous access to all of the content stored by the peers would constitute a major leap forward, and no doubt prove more convenient than “classic” Web-based download services.

The massive adoption of file sharing in day-to-day communication processes would have a major impact on content distribution business models. The boundaries between radio and music sales, and between TV and video sales, could ultimately vanish.

Today’s major content distributors could lose their edge on the value chain as producers and publishers “inject” content into the networks, using DRM to monitor file sharing and invoicing via micro-payment mechanisms included in all communication systems, both fixed and mobile. In addition, super-distribution systems would reward peers who are influential in their community.

The concept of exclusivity would disappear, as P2P maximises the distribution of content over the largest possible network. The legal framework would evolve, incorporating the notion that any use of content is authorised, provided that it is covered by a DRM system.

Under this long-term view, the “one-to-many” content distribution model, inherited from the offline world, disappears. It is the very nature of the Internet’s “point-to-point communication” that drives the online circulation of content. (Source: EITO 2006, p. 149f)

An interesting exercise on the future of DRM and piracy was also performed starting like this: Imagine 2012 and the problems of digital piracy are solved. A backcasting

[114] Armstrong, T.K.(2006): Digital Rights Management and the Process of Fair Use.

exercise demonstrating the great significance of the issue and looking at the situation in 2012 when all problems of digital piracy would have been solved took place in a workshop on digital piracy in Davos in the context of the World Economic Forum. From the business perspective easy access, value for money, plentiful and cheap offerings of legitimate content were said to be key, from the legal perspective regulatory harmonization and global enforcement, and from the technology perspective standards for consumer electronics devices and support for standards for content formats, protocols, authentication, DRM, and so on were considered necessary. The standards included universal online identifiers for people, but did so in a way that respects privacy. In addition a change of social norms was addressed aiming to increase respect for copyright by making it "cool".[115]

During 2007, there were moves from the US Justice Ministry to actually increase criminal penalties for copyright infringement, including even “attempts” to commit piracy. Additionally, the penalty for the use of pirated software could be up to life imprisonment if the use of counterfeit products recklessly causing or attempting to cause death, e.g. through the use of pirated software in hospitals. Other changes include more ready seizure of computers intended to be used to commit copyright crimes and permitting wiretaps for piracy investigations.[116]

2.2.6 Working life

a) Competition for the “creative class” and regional development

The final report from FISTERA already argues that there is global competition for well-educated, skilled staff needed to accomplish the transition to knowledge economy. It notes that there are a number of factors making Europe attractive as a location for such work, but also that there is a flow of talent from the poorer to the richer countries, namely from the New Member States to the well-established EU member countries in Western and Northern Europe, and from the EU as a whole to the states. South Korea is faced with much the same problem and is devising a strategy to attract foreign researchers and engineers into Korea.

Almost at the same time as the “creative industries” captured the attention of policy makers, a book was published by the Hirst Professor of Public Policy at George Mason University[117], Richard Florida on the “Creative Class”.[118] According to Florida, human creativity is possibly the decisive source of competitive advantage and thus he focuses his attention on a whole “class” of knowledge workers including researchers and others whose main function is to create new ideas, new technology and new creative content. To this core are added other professionals engaged in complex problem solving involving independent judgement, such as lawyers and medical professionals. According to Florida, cities are the key economic and social organizing units of the creative age. They promote economies of scale, incubate new technology, and match human capital to opportunities, ideas to places, and innovations to

[115] The summary given on the piracy workshop is based on the report of a participant; cf. Rosenblatt, B. (2007): Digital Piracy Workshop at World Economic Forum.

[116] McCullagh, D.: Gonzales proposes new crime „Attempted copyright infringement“. C-net News, 15 May 2007. http://news.co.com/8301-10784_3-9719339-7.html

[117] Ironically, Florida has recently taken up an appointment in Toronto, Canada, possibly a consequence of the deteriorating conditions for the creative class in the US identified in his own recent works.

[118] Florida, R. (2002): The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life. New York.

investment. They capitalize on the often chaotic ecosystem that creates previously unforeseen financial, scientific, social, political, and other linkages to one another.

Florida has developed a set of indicators to measure the degree to which environments are favourable to attract members of the creative class, in particular through “lifestyle factors”. In 2004, Florida and a co-worker adapted these indicators to be able to use existing statistics for Europe and applied them for a group of 14 European countries. The creative class accounts for more than a quarter of the workforce in 7 out of the 14 countries examined. Members of the creative class outnumber blue collar workers in 6 countries.

The creative class is growing quickly in most countries, with Ireland leading with an annual growth rate of 7% from 1995-2004. Some countries are lagging, e.g. Italy and Portugal with fewer than 15% of the workforce from the creative class.

The US is still world leader in technology and in its ability to attract talent, but the Northern European nations (Nordic countries, Benelux) are competitive. Immigration policies and integration are still deficient compared to the US and Canada. Due to US policy in the age of terrorism, the US is decreasing its attractiveness for immigrants in particular the creative class. This is an opportunity for regions with more liberal policies.[119]

Within Europe, there is a shift of competitiveness from the traditional powers (France, Germany, UK) to Northern Europe. Ireland stands out as an up-and-coming nation.

The creative sector has been recognised as an important economic factor, both from the viewpoint of commercial sales and from the viewpoint of innovation. While the United Kingdom, with its image of “Cool Britannia”, was probably the first country to grasp the importance of the creative sector and to develop specific strategies and statistical reporting for the sector, other countries have been quick to react, particularly at the regional level.

London promptly donned the mantle of the “creative capital” of the world, linking with the “swinging London” image of the 1960s. Over half of all Internet content is produced in the US, about half of the US’ share is produced in 5 cities, underlining the importance of cities as “creative clusters”. Despite the “disappearance” of space and time due to information and communication technologies, favourable environments and infrastructures still lead to the concentration of creative activities in such cities as London, New York or Paris. Among the components of infrastructure important for this development are “high-tech poles”, i.e. universities, training colleges and companies serving the creative sector’s needs.[120]

A 2007 cover story in the German news magazine “Der Spiegel” has focused attention on “cool second cities”, like Dublin, Vienna, Amsterdam, Barcelona, Tallinn, and Copenhagen,[121] which are challenging the traditional cultural metropoles of London, Paris, Madrid and Berlin.

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[119] Cf. Florida, R.; Tinagli, I. (2004): Europe in the Creative Age. London, Demos
[120] KEA (2006) The economy of culture in Europe, p. 167
[121] http://www.spiegel.de/international/europe/0,1518,502297,00.html

Recent years have seen a profusion of national and regional reports on the creative and cultural industries. According to national constitutions, responsibility for creative and cultural affairs frequently rests with sub-national levels of government such as municipalities or regions. Accordingly, many of these reports have been produced by or on behalf of major cities or regions seeking to position themselves as "creative hubs". There are reports on the large Western European Capitals, such as London, Paris, Vienna and Berlin, but already 11 of the 16 German *Länder* have their own reports.

These serve at least a two-fold purpose:

1. To provide a factual basis for the development of policy measures targeted at attracting economic activities from the creative industries and at providing support of the many small and medium sized enterprises active in the field;
2. To advertise the location as attractive for the creative industries and members of the "creative class". Frank Webster notes, "What is especially interesting is that cities attain, and reach towards, particular imagery – as action-packed, as galvanising, as powerful, as centres of cultural innovation and availability".[122]

Such reports have been produced for the US, Australia and the city-states Hong-Kong and Singapore. Up to now, there appear to be no national-level reports for China or India, but there are signs that decision-makers in these countries are aware of the economic significance of the creative sector.[123]

Some of the reports include recommendations or proposals for the support of the creative industries:

- A report on design in the Nordic and Baltic countries[124] proposes setting up a set of "virtual platforms" to enhance communication between key institutions in the creative industries. New innovations are offered to SMEs in the region.
- In the Nordic countries again, there are initiatives to strengthen ties between the computer games and medical devices industries[125] and for a knowledge platform and forum for the games industry.[126]
- The report on the cultural industries in Berlin proposes the creation of an infrastructure, including joint marketing platforms on the Internet.
- The Île de France region around Paris has created a business pole "Cap Digital".
- The report for the Canterbury region surrounding Christchurch in New Zealand[127] recognises special needs related to marketing and training, including better linkages between the industry and educational institutions.
- A report on Australia[128] describes the major barriers for Australia's creative industries, most of which apply equally for Europe: industry fragmentation,

[122] Webster, F. (2003): Globalization, Nations and Culture in the Information Era, In: Bechmann, G., Krings, B.-J., Rader, M. (eds.): Across the Divide – Work, Organization and Social Exclusion in the European Information Society

[123] E.g. CGA (2004): Changing China – The Creative Industry Perspective

[124] Järvinen. J., Koski, E. (eds.) (2006): Nordic Baltic Innovation Platform for Creative Industries

[125] Avellán, L. (ed.) (2006): Medical Imaging and Computer Games

[126] Åresund, M. (2006)**:** Nordic Playground

[127] Canterbury Development Corporation (2002): Creative Industries Mapping Study – Pilot Project Christchurch & Canterbury.

[128] Department of Communications, Information Technology and the Arts, National Office for the Information Economy, AUS (DCIT) (2002): Creative Industries Cluster Study – Stage One Report

poorly developed business models, uncertainty with regards to digital rights management, access to some skills, and financing problems due to high risk.

- The study on Singapore[129] has the goal of developing "a vibrant and sustainable creative cluster to propel the growth of Singapore's Creative Economy", specifically to double the contribution of the creative cluster to Singapore's GDP from 2000 to 2012, and to establish Singapore as the "New Asia Creative Hub". This includes the development of three industry-specific visions as frameworks for strategies:
    - A renaissance city, based on the arts and culture
    - A "global cultural and business hub for the design of products, contents and services"
    - A "global media city" building on a thriving media ecosystem (p.V)

What becomes apparent from these examples is that the creative industries have been discovered globally as an important competitive factor. Asian countries, for example, have started to discover design drawing on their own cultural heritage as an important asset, or have identified specific forms of pop music as products to be exported at least throughout Asia (e.g. Hong Kong). The phenomenon of "Bollywood" is perhaps indicative of future developments spreading beyond the film industry.

Cultural and creative goods first and foremost cater for local audiences, increasingly in competition with "international products". The local component, including the use of local language, makes the sector overall less susceptible to off-shoring. However, due to the international nature of the markets in these fields, the production of video games and the cinema industry are still vulnerable, since 80% of box-office sales are generated by productions from Hollywood and other regions (e.g. some Asian countries and Montréal in Canada) are seeking to establish themselves as hubs for the video game industry. Thus there is the strong danger of a brain drain from Europe to other countries.

Nonetheless there are also European hotspots, such as the North-East of Scotland or the Nordic Countries for video games and some nations still have strong film industries (Spain, France, to a lesser extent Germany). Florida, one the other hand, recognises a danger from the viewpoint of the US that a drain of talent could flow in the opposite direction due to unfavourable conditions in the US and more attractive conditions elsewhere including Europe, e.g. Wellington in New Zealand for film makers (cf. Florida 2005).

The creative hubs to some extent provide a platform to exhibit and test creative ideas, which if successful, can be exported elsewhere. A particular challenge is to enable this export beyond traditional barriers, such as those due to language or culture.

On the one hand, it would be very useful for European cities with activities to foster the creative industries to be able to share experiences and benefit from good practice elsewhere, but on the other hand, there is global competition to attract both companies and to attract, nurture, foster and retain the members of the "creative class", both as a competitive asset and as tax-payers.

[129] Economic Review Committee, Services Subcommittee (ERCSS) (2002): Creative Industries Development Strategy – Propelling Singapore's Creative Economy

b) The rise of the "prosumer" and the "ugrammer"

In this section we are concerned with a trend towards what is called "social software" and a blurring of the distinction between producers and consumers, leading to the new category of the "prosumer", a term coined by Alvin Toffler. A related term is that of the "ugrammer", used for the blurring distinction between users and programmers. Ugrammers are users of software also programming the software they use.

The Internet, in the Web2.0 incarnation, is enabling a new type of creative sector, and incumbent creative industries are struggling to adapt and jump on the bandwagon. In doing so, they are competing with net-native companies. A Deutsche Bank report calls this the "third era of media history", noting that "Web2.0 merely documents the realisation that the internet was never just a digital marketplace but always a social forum for exchanging opinions and knowledge".[130]

1. The Internet is the basis for an explosion of creativity in terms of user-generated content. This phenomenon has also been termed "the rise of the amateur"[131] TIME magazine, declared "you" the "person of the year" and enthusiastically proclaimed: "… millions of minds that would otherwise have drowned in obscurity get backhauled into the global intellectual economy".[132]

   The emergence of user-generated content depends on new technologies that are accessible and affordable to the general public and allow for easy content production. These start with simple HTML-editors and webpages, and lead to P2P-networks, blogs, wikis etc. The more recent tools are sometimes addressed as "web 2.0"[133] (see also section 2.4.2 above).
2. As early as 1991 Edward Barrett, MIT, coined the term "sociomedia", which suggests that computer media exist for 'social' purposes: as means to objectify, exchange and collaborate, invoke, comment upon, modify, and remember thoughts and ideas (including 'information')".[134] Sharing, recommending, discussing, gaming and again and again self-expression are presumably main purposes and strong motivations behind these new digital media. Concepts like "social media" or "conversational media" as well as "social software" or "community-driven services" underline the importance of (virtual) communities in this context.
3. Notwithstanding the "conversational" nature of Internet-media, the information function is in many cases still predominant. A keyword in this context is "distributed intelligence" (attributed to Friedrich v. Hayek), with open content as sort of an equivalent to the open source movement. Wikipedia, the online encyclopaedia, is the most famous example of this type. Social bookmarks, open access archives etc. can be added.
4. The Internet is also the basis for a wealth of secondary media produced by services exploiting and tailoring the available content in many forms. Sharing of content via P2P networks, syndication, aggregation and mash-up of content as well as searching and organising content, filtering, datamining etc. constitute ICT-based

130 Deutsche Bank Research (2006): Media Industry facing the biggest upheaval since Gutenberg – Media consumers morphing into media makers, p.8
131 Howe, J. (2007): Crowdsourcing: Tracking the Rise of the Amateur.
132 Grossman, L. (2006): Time's Person of the Year.
133 Cf. Madden, M.; Fox, S. (2006): Riding the Waves of "Web 2.0".The buzzword itself however lacks a precise meaning. Most of the developments congregated under the heading had emerged before it was ever coined, so that the transition from web 1.x to web 2.0 has been evolutionary rather than a radical disruption.
134 Barnett, E. (ed.) (1992): Sociomedia

new media content. Google as a media company without proprietary content is the most striking case of a creative content company based on ICT skills. The more the overall content available on the Internet is growing, the more do techniques matter which help to select, structure, and analyse the amount of information in order to produce tailor-made information products and services.

To sum up: What is different from old media on the Internet is on the one hand their direct, interactive and social character and on the other hand their character as programmable ICT-based media. This character is most visible in the continuous invention of new media formats and in the algorithmic exploitation of the available content. This segment of the content industries is neither covered by current WIPO classifications nor by most studies on the creative industries.

Opportunities and Trends

Media websites are currently taking away market shares from the newspapers. Newspapers are on the other hand developing various strategies for the use of the web, such as complementary websites and new features like podcasts. Radio is also complementing its current business, without, however, revolutionising it.[135] TV is predicted to offer interactive and personalised programming, independent of scheduling on the part of the TV company. Such a development would undermine the current business models relying on advertising: there would no longer be any prime time or fixed advertising blocks. TV advertising would have to undergo fundamental change. Among the options being discussed are the use of split screens, crawl messages (which are scrolled across the screen) and branded entertainment, where advertising is integrated in the program introduction.

Apparently the IT-industry has leveraged the potential of the Internet more successfully than incumbent large media companies: it was the IT-company Apple with its service iTunes which first demonstrated that commercial music shops could be profitable. It was the developers of search engines like Google who started to organize the world's online content and to develop secondary media and services on this basis, and finally amateurs have invented some of the new Internet media like blogs and wikis. Nevertheless media companies are catching up.

Copyright industries are being challenged by the mass of amateur-generated free content and the wealth of content available from the public domain (and in part from public entities). The amount and quality of this somehow free content is the benchmark for commercial copyright industries to build more attractive, competitive offerings.

A clear opportunity for the content industries can also be derived from the "Long Tail" effect (coined and popularised by Anderson[136]). This applies both to large retailers like Amazon and to small producers doing their own distribution. Impacts of the Long Tail phenomenon are catering for minority tastes and overall greater choice for individuals. From the angle of cultural workers, the Long Tail has the potential to help creativity flourish across all fields where it comes into play.

[135] Deutsche Bank Research (2006): Media Industry facing the biggest upheaval since Gutenberg – Media consumers morphing into media makers, p.6.

[136] Anderson, C. (2004): The Long Tail.

Media companies have also a choice to turn from creating on-line content to creating the facilities and framework for amateurs to publish their own content in prominent places. Early examples of user generated content include bulletin boards and groups on portals such as AOL and Yahoo. MySpace acquired by Rupert Murdoch's News Corporation last year is the most prominent example today. In the same vein net-native "secondary media"-companies like Google bought YouTube and Yahoo! acquired Flickr. According to an expert survey these "platforms will essentially be financed through a special form of online advertising, so-called pay-for-performance ads. Other financing models are based on commission models and traditional online advertising formats", user charges are hardly viewed as viable.[137]

Another strategy of media companies is to add to platforms of user-generated content. A recent example is the announcement of Warner Music Group to add its whole catalogue to LastFM an Internet radio and recommendation service.[138]

Content industries have to take the *new producer-user relation* into account. The Internet holds also great opportunities for mixed media where amateur content and professional content and expertise are brought together (e.g. "citizen journalism"). In the end there is no impermeable dividing line between amateurs and professionals. Amateurs may become professionals as happens with open source programmers, and we observe the same with respect to blogging. In any case the Internet is a huge talent stock exchange for the creative class.

We agree with Hunter and Lastowka: "The movement which we characterize as "amateur-to-amateur" will inevitably mean that copyright's empire—as the central, all encompassing structure for the development of content—will decline and fall. New tribes of amateurs will emerge, and become significant forces in cultural content. However this doesn't signal the end of copyright altogether."[139] However we also have to see the copyright enforcing latent function of users producing content which others find interesting and rewarding. Producing high quality content will make users more aware of copyright. The CC-licensed documents are a good indicator for this. More than 60 million works with a Creative Commons license, an alternate licensing scheme, have already been made available online by individuals.[140]

In a different vein, the latest developments on the Internet have also attracted the attention of the so-called "third sector", voluntary organisations and charities. Innovative organisations of this type not only have their own websites, but also social networking software to make themselves visible in new networks. The communities concerned can be either "bounded" (with registration of members to join forums or to create relevant blogs) or "personalised", meaning that individuals have created their own fluid participative networks of interest.

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[137] Deutsche Telekom, Hubert Burda Media, Euro Lab for Electronic Commerce & Internet Economics (2006): Deutschland Online 4 — The Future of Broadband Internet (online).

[138] Reuters (2007): Warner Music enters social-networking content deal

[139] Hunter, D. and Lastowka, F. G. (2004): Amateur-to-Amateur.

[140] This figure is taken from Geist, who has written an interesting report on the 2006 OECD conference on digital content in Rome. In his report he emphases the achievements of the amateur movement, which were not yet common wisdom at the conference. Cf. Geist, M. (2006): Locking down our digital future.

It is no longer sufficient for VCOs to simply push out information from the centre. People now expect organisations to pull in information from other sources.[141]

c) Convergence of working life and leisure time

Since the availability of personal computers and the realisability of home working for large numbers of workers, there has been much discussion on the opportunities and dangers of working and living in the same location. Technological development and quicker and more powerful communications will enable more home-working and allow the reduction of office space. It has already been pointed out in connection with pervasive computing that there is in the societal area a virtual merger of social, working and family roles, making pervasive computing an extension of "anytime, anywhere" culture.

The Sigma Scan for the UK Foresight Directorate's horizon scanning activity anticipates that impacts could include changed working hours, attitudes to work, environmental impact through reduction of commuter traffic, changes to the structure of cities. Greater use of flexi-time is likely. The distinction between home and work could blur, the reduction of cohesion in offices is possible.

A pervasive culture of work may emerge in which economic security and prosperity come at the price of excessive working hours, health and well-being.

The speed and ubiquity of IT-enabled communication and the move towards a more "24 hour" consumer society are creating pressure on employees and employers to work longer to maintain competitiveness.

On the other hand we have already seen that technologies and practices will be developed to enhance established cooperative working and working in ad-hoc groups, e.g. self-organisation mesh networks, community computing grids, social mobile computing, peer production networks, social software, social accounting methods (rating, ranking, referral mechanisms to build trust), knowledge collectives. The new tools can support the emergence of new markets and spaces for the creation of economic value.

Implications include:

- The shift to more informal ad-hoc collaboration in organisations
- Shortening of innovation and development cycles for new cooperative technologies
- Increased effectiveness of rapid decision-making within organisations
- Increased effectiveness of online economies against off-line due to effective trust mechanisms.

Indicators of this development are the rapid spread of wikis and blogs, the appropriation of art and media through mash-ups and remixing and the formation of clans in MMPOGs.

[141] NCVO Third Sector Foresight (2007) – ICT Foresight – How online communities can make the net work for VCS. http://www.ncvo-vol.org.uk/3sf/

This development is being enabled and driven by increasing broadband penetration, the development of advanced mobile devices and wireless data networks, and the continuing development of software agents. The events needed for this to happen will take place in the next 3 to 10 years.[142]

d) The personal fabricator

Personal fabricators (PF) are in some respects the extension of the web 2.0 or "prosumer" concepts into the physical world. One of the major forces behind the development of this approach is the Massachusetts Institute of Technology's "Bits and Atoms" lab, headed by Neil Gershenfeld, otherwise known as a pioneer of quantum computing.

Equipment originally intended for "rapid prototyping" was applied in a course, mainly directed at non-computer specialists on "how to make (almost) anything". Gershenfeld's goal was originally to enable cooperation between students from a range of scientific disciplines to solve emerging problems.[143] The course proved extremely popular and led to the vision of personal fabricators, capable of shaping and assembling various raw materials into any kind of physical artefact, including toasters, shoes, bicycles. Beside the one off option, the PF can also be used to manufacture items to set specifications, e.g. those sent to remote places by e-mail. It would also be feasible to distribute designs made by amateurs to other people with a liking in the object: a "Wired" article cites the example of a plastic exterior for an MP3 player which proves so popular that it attracts the interest of a commercial manufacturer.[144]

Shoes from the personal fabricator

Personalised boots for professional sportspeople are produced by first scanning the sportsperson's feet to obtain a digital model. The person then has to carry out a series of exercises while wearing a force-recording insole called a pedar. This determines the magnitude and distribution of forces acting on their feet. That information is combined with a detailed analysis of their foot and leg structure and gait information to produce a template for the sole and stud arrangement, around which the rest of the shoe is based.

The finished design is generated from the blueprint and printed by a technique, developed by Siavash Mahdavi at University College London.. The software breaks up the design of the sole into hundreds of smaller parts and calculates the forces each sub-component will experience. The programme calculates the microstructure appropriate for each particular part of the sole and the 3D design is replicated by a laser printer. The shoe can be lighter than one designed by conventional means by tailoring the thickness, density and strength of the material for each sub-component. According to its inventor, the technique can be employed to design other objects with very complex properties.

Adapted and abridged from: Graham-Rowe, N.: Tailor-printed shoes offer a perfect fit. New Scientist, issue 2538, 15 February 2006, p. 30.

142 Delta Scan: New Technologies for Cooperation.
143 Bits and Atoms – An Interview with Neil Gershenfeld. Educause, March/April 2002, p. 36.
144 Thompson, C.: The Dream Factory. Wired 13.09. http://wired-vig-wired.com/archive/13.09/fablab_pr.html

Up to now, applications in industrialised countries have been restricted mainly to the "one-off", personalised items also developed in the educational environment, but serious use of the concept has been made in developing countries like Ghana and India and a remote location in Norway, where a shepherd built GPS enabled tags to track his flock.

The "Wired" article points out the problem of artefacts being flawed due to designers' lack of experience, noting "even the flaws are charming".[145]

Gershenfeld's vision of the personal fabricator builds on prices for equipment falling – not unlikely in view of experience with PCs and printers, which are related to the PF – one well-known example is a "printed bicycle". At the industrial level, use is already being made of the concept: A company known as "Phonax Hearing Systems" scans the inner ears of hearing aid users to determine their form, which is as individual as a fingerprint. The data model produced by a computer is then used to manufacture a tailored shell for the hearing aid.[146] Similarly, a 3d printing technique called selective laser sintering is being used by Prior 2 Level to fuse together particles of a nylon-based material to make shoes for professional sportspeople, such as British Premiership soccer players. Ultimately, the process will be taken to the high street to "print" bespoke shoes in just a few hours.[147]

A newspaper article from 2006 notes that fabrication machines still cannot produce anything larger than themselves and that some processes are still restricted (e.g. length and depth of laser cuts).[148]

The cheapest professional "personal fabricators" currently cost about €30.000, laser sinters are from €200,000. Material is still fairly expensive at €80-120 per Kg.[149]

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145 Ibid,.
146 Boeing, N.: atoms at your fingertips. Hamburg, March 2004, Km 21.0: http://www.km21.org
147 Graham-Rowe, N.: Tailor-printed shoes offer a perfect fit. New Scientist, issue 2538, 15 February 2006, p. 30..
148 Dunn, K.: How to make (almost) anything. The Boston Globe, 30 January 2005, http://www.boston.com/news/globe/ideas/articles/2005/01/30..
149 http//www.network-newculture.net/htep_fabricator.html, accessed 27 July 2007.

3. CONCLUSIONS

3.1 Priorities overseas and in Europe

For this first edition of the AMS report, only three new national foresight studies have been covered, but these are all from current or future principal competitors of the EU in the global economy:

- India, as a democracy, expresses the intention to enable a large proportion of its population to benefit from its rise in the knowledge society;
- China – here it is sometimes difficult to discern the real technological developments behind some of the items given priority in a Delphi survey, but it is remarkable to see that IT security is given high priority;
- Japan appears quite confident in its own abilities to achieve progress, perhaps underestimating the European Union due to lack of understanding about the Union among the experts participating in the Delphi survey – it is quite possible that individual EU Member States would be ranked higher than the EU as a whole, had the questionnaire included such an option. The Japanese study is very much under the influence of the terrorist attacks at the beginning of this decade and indeed states: "This can be seen as reflecting society's current anxiety and social demand for greater safety".[150]

Apart from perhaps being underrated by Japanese experts for the reasons explained above, Europe and the EU are seen as having a strong emphasis on security, privacy and data protection which is sometimes regarded as anachronistic in the oncoming information society. However, elsewhere too, there seems to be increasing awareness of a need to address issues related to these topics in technological development. This can be due either to the fact that the issues of privacy and data protection are more pervasive and universal than some experts would have us believe, or to the strength of the European position through the existence of framework legislation that simply cannot be ignored by technology developers.

A comparative study by CMI and others[151] finds that in IST, Europe has a less prominent scientific position than the US and Japan. With respect to the efficiency of public policy support, Europe is in at least as good a position as the US, but the US spends twice the amount that Europe does. Japan is comparable in terms of spending, but seems to be more efficient in its use of funds. Europe puts stronger emphasis than the US or Japan on societal factors (Europe supports IST, the US and Japan ICT). Either Europe has a weak industrial base in the area, or the links between basic R&D and application development in industry are weak. Europe has particular strengths in 4G mobile communications and also relatively well-positioned in embedded single-chip applications, microsensors and nanosensors, software technologies for the transport of digital data and individualised health services and drugs. The latter also receives a particularly high level of public non-financial support, while an item "advanced technologies for virtual/augmented reality" receives only weak support.

In the technological realm, it is perhaps worth noting that despite the emergence of foresight as a non-deterministic method to explore possible futures, there are still many quite confident

[150] NISTEP: Eighth National Japanese Science and Technology Foresight (2035). Tokyo, 2005, p. 95

[151] CMI International, ICTAF, VTT, Z-Punkt, North Carolina State University, Institute for Industrial Interchange (2006)*:* Emerging Science and Technology priorities in public research policies in the EU, the US and Japan

predictions and visions of what the future will or should be like, in particular related to artificial intelligence, e.g. “Machines may well have consciousness by 2015, with intelligence levels comparable with people”,[152] or the vision of a new renaissance of science through nanotechnology contained in the 2002 Roco/Bainbridge book on convergence. Whatever the likelihood of such visions and predictions, they are proving influential in agenda setting, depending on their authors and whether they strike a resonant chord for stakeholders with an interest in the subject of the vision.

3.2 Technological aspects of convergence

The previously separate networks for voice communications, radio and TV broadcasting and data exchange are converging in a single broadband infrastructure capable of transmitting all kinds of information both for stationary and mobile devices. In the past, the “silos” forming communications networks were each subject to their own regulations. Broadband convergence requires regulations having a consistent, equivalent and non-divisional character.

It is expected that progress towards the goal of “**broadband for all**” will continue, although there are still issues to be resolved before remote areas have full access. This obviously also applies to developing countries hoping to leapfrog the “fixed line stage”. Wireless technologies are still more expensive than fixed lines and there is the problem of limited capacity of WIMAX in remote, but rather more densely populated settlements.

Activities in the US related to the convergence of nanotechnology, biotechnology, information technology and the cognitive sciences (**NBIC Convergence**) have been hugely influential throughout the world. The reaction of the European Commission has been to develop a typically “European Counter vision”, Converging Technologies for the European Knowledge Society (CTEKS). This is typically European in that it emphasises interdisciplinary cooperation, whereas the US NBIC concept propagates the dominance of nanotechnology over other disciplines.

The European CTEKS concept gives supremacy to humans (“engineering **for** the mind” as opposed to “engineering **of** the mind”), while the US concept gives emphasis to the goal of enhancing human performance (thus also in the title of the seminal report on the topic).

NBIC convergence as a topic of research policy has attracted a strong lobby of so-called transhumanists both in the US and the EU. The vision underlying such lobby work is that of an enhanced breed of super-humans, in some cases contrasted as more “benign” with the vision of a race of completely artificial “mind-children” who succeed “humans as masters of the Earth” (strong Artificial Intelligence à la Hans Moravec).

The vision of human enhancement relies heavily on the continued validity of Moore’s law to produce within a few years computers surpassing the capacity of the human brain on all counts. Perhaps more crucial are advances in the cognitive sciences, in particular the ability to interpret brain scans and to reproduce cognitive processes deliberately, either by neural stimulation or by mechanical reproduction, if possible employing principles due to nanotechnology.

Progress in some areas, such as retina or cochlear implants and treatment of neural disorders like Parkinson’s diseases, has already been made, but there is still a long way to go, even before applications of this kind are routine: one of the studies analysed for this report still

[152] Innovation BTplc technology e-zine: The future is female. 12 July 2006. http://www.btplc.com/Innovation

discusses the use of acoustic signals as an aid to the blind as a promising future development.[153]

There is a degree of disagreement whether the cognitive science will play the key role in this convergence or whether “synthetic biology”, a kind of biological re-engineering, is not a more promising avenue.

While concepts of convergence, in particular the NBIC concept in the US, have attracted much attention, there are still no large-scale programmes under this heading in the US: relevant work is under the headings of nanotechnology or cognitive sciences. Furthermore, the EU high-level expert groups proposes a shift in the development of actual applications away from human enhancement towards more urgent topics like combating obesity, translation systems for greater inner-European cohesion, or applications in “intelligent dwellings”.

Pervasive computing indicates a qualitative change in the use of ICTs rather than a single new technology. It relies on advances in a number of fields, such as infrastructure, devices, diffusion of embedded systems in cars, homes and household appliances etc. RFID as a crucial component is already on the threshold of a massive roll-out.

There is a need to increase the awareness and understanding of the behaviour of such extensive and complex systems, since there is a strong danger of unpredictable behaviour.

In the social sphere, there is the likelihood of a virtual merger of the social, working and family roles. Thus a question perhaps not sufficiently addressed is the extent to which pervasive computing really responds to human wishes, desires and needs. What benefits does the “always-online”, “anytime, anywhere” culture really bring to individuals?

Privacy and data protection are again crucial factors which need to be addressed and settled before pervasive computing can achieve a breakthrough.

There are at least two major guiding visions for the **Internet of the Future:**

- The **Internet of Things** is strongly related to concept of pervasive computing, having as an important element the universal use of RFID. This is also a vision requiring for its realisation progress in such matters as standardisation. It is described as a particular opportunity for such developing countries as India and China.
- The key characteristic of the **Web2.0** is the empowerment of the user, which provides job opportunities for a new type of software developer and involves the consumer as a co-producer of services and products (the “prosumer” after Alvin Tofler). The mobile Internet is a particularly powerful vision in this context.

Data storage is rather less of a problem with larger capacities possible with both volatile and non-volatile technologies, e.g. disk drives and flash memory.

Power needed to realise all visions linked with mobility of users is still a major problem, despite considerable progress with power-saving techniques and batteries. Reliable and adequate power is needed to realise many visions of ICT use. A combination of power

[153] Silberglitt, R., Antón, P.S., Howell, D. R., Wong, A.: The Global Technology Revolution 2020, In-Depth Analyses: Bio/Nano/Materials/Information Trends, Barriers and Social Implications. Santa Monica: Rand 2006

scavenging or harvesting with power storage seems a promising approach, but there is still much need for research and for the exploration of alternative options.

3.3 Citizens' concerns

Privacy and data protection remain important items on the agenda. Their satisfactory resolution is crucial for many envisioned applications and grand visions, such as pervasive computing. It is sometimes argued that citizens would be willing to surrender some privacy in return for (economic) benefits or increased societal security, but this requires the setting up of a societal discourse to achieve a solution agreeable to a maximum number of actors and stakeholders.

Despite the finding of the FISTERA Delphi survey that applications of ICT to achieve greater **security** did not have great priority for European actors, the documents reviewed for the AMS report mentioned many applications in this area and the Japanese foresight study actually described security as a primary concern of society. The security **of** ICT systems is a pervasive theme and has a perhaps surprisingly high priority for China according to the Chinese foresight study.

A security-related issue seldom addressed in forward-looking studies is that of concepts to save proliferating amounts of data over time. While capacity of storage media should not be a real issue, there is the problem of strategies to transfer data from one medium to another as older media become obsolete.

Only the Indian foresight study appears to explicitly address the problem of the **digital divide**, although here the focus is on the problem of education in general. Since the goals of education implicitly include computer literacy and computer-assisted teaching is a major instrument in India's strategy, tackling the divide is naturally part of the strategy.

In most other studies, bridging the divide is mainly viewed as a matter of getting on-line. This does not mean that the aspect of computer literacy should be ignored, but more that online access is given priority in the studies analysed.

Digital rights management has particular relevance in this year's focus of EPIS on the creative industries. Its use is partly regarded as an important measure to combat piracy of music, films and other forms of media, but perhaps more importantly it is an important element of business models in the field. DRM systems have always been controversial, both among the actors in the field, where it is seen as a means to seal off segments of the market from competition, but also among customers, who view DRM as infringing on established rights. Forensic digital rights management, which is not automatically perceived as restraining consumer behaviour, is a viable alternative as is a tiered pricing system giving more rights to customers willing to pay more. It is also important to devise schemes for exemption for user groups like disabled persons, educational and research establishments and libraries. Latest US legislation seems to be moving in the direction of greater criminalisation of copyright infringement.

3.4 Working life

The problem of **supply of creative talent** is at the core of the now popular concept of the creative class, developed by Richard Florida.[154] In a similar vein, the British government heightened awareness of the role of creative workers through its “Cool Britannia” campaign. Since then, many regions throughout the world have discovered creative work as an important asset for their economic development and correspondingly have begun to produce statistics and strategies to help attract creative workers and industries.

On the one hand, it would be very useful for European cities with activities to foster the creative industries to be able to share experiences and benefit from good practice elsewhere, but on the other hand, there is global competition to attract both companies and to attract, nurture, foster and retain the members of the “creative class”, both as a competitive asset and as tax-payers.

While the transition to the so-called Web2.0 has been incremental and gradual rather than revolutionary as the label may suggest, the most striking change has perhaps been the gradual transition of the **role of the consumer** to that of a **co-producer** of services and goods, the **“prosumer”**, following Tofler. Content industries will have to take this *new producer-user relation* into account. The Internet holds also great opportunities for mixed media where amateur content and professional content and expertise are brought together (e.g. "citizen journalism"). In the end there will be no impermeable dividing line between amateurs and professionals. Amateurs may become professionals as happens with open source programmers, and we observe the same with respect to blogging. The Internet is a huge talent stock exchange for the creative class and also providing opportunities for setting up new businesses. As elsewhere in innovation, the European system of venture capital und support for set-ups is inadequately prepared for these developments, so that there is at least need to create greater awareness of future directions of the web and the business opportunities these will provide.

The availability of new IC technologies is leading to a virtual merger of social, working and family roles, making **pervasive computing** an extension of “anytime, anywhere” culture in the societal area. On the one hand, this could lead to decreasing well-being and health of the working population, and also to weaker cohesion in offices, but also to a changed structure of cities (fewer offices) and a reduction of commuter traffic with a resulting positive environmental impact. The developments expected here could be at odds with the assumed role of creative hubs in approaches related to the “creative class”, so there is some need for research to develop balanced strategies to both attract creative workers, to enable environmentally benign urban development and to prevent negative impact on citizens.

Personal fabricators which can be considered an extension of the "prosumer" into the physical world are a promising vision, but it is not yet clear which practical applications will emerge in the short run. It is currently being used for personalised items both at the high end of the product range and by amateurs in addition to pioneer use in developing countries. The viability of the concept for decentralised production of standardised items and the related materials/quality issues require further investigation.

[154] Florida, R. (2002): The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life. New York.

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ACRONYMS / GLOSSARY

Acronym/ Term	Description
API	Application programming interface
B2C	Business to consumer
BT	British Telecom
CC	Creative Commons
CCTV	Closed circuit television
DNA	Deoxyribonucleic acid
DRM	Digital Rights Management
DRMS	Digital Rights Management System
EITO	European Information Technology Observatory
FFTH	Fibre to the Home
GB	Gigabyte (1000^3 bytes)
HTML	Hypertext Markup Language
ICT	Information and Communication Technology
ID	Identity
IMS	Internet Protocol Multimedia System
IP	Internet Protocol
IPR	Intellectual Property Right(s)
IST	Information Society Technology
IT	Information Technology
ITU	International Telecommunication Union
MMPOG	Massive Multiplayer Online Game(s)
MP3	Moving Picture Experts Group Audio and Visual Standards, Audio Layer 3
nano	a factor of 10^{-9}
NBIC	Nanotechnology, Biotechnology, Information Technology, Cognitive Science convergence.
NGN	Next Generation Networks
NGO	Non-governmental organisation
OLED	Organic light-emitting diode
OLEP	Organic light-emitting polymer
PC	Personal computer
P2P	Peer to peer
PDA	Personal Digital Assistant (device)
Petaflop	10^{15} operations/second
PF	Personal Fabricator
QC	Quantum computing
QOS	Quality of Service
RFID	Radio Frequency Identification
RTD	Research and technological development
SDRAM	Synchronous Dynamic Random Access Memory
SME	Small and medium-sized enterprise
terabit	10^{12} bits
VOIP	Voice over Internet Protocol (internet telephone)
VR	Virtual Reality
Web2.0	A perceived second generation of web-based communities and hosted services which aim to facilitate collaboration and sharing between users
WLAN	Wireless local Area Network
WiMAX	Worldwide Interoperability for Microwave Access
WIPO	World Intellectual Property Organization

ANNEXES

I. Broader and Multinational Studies

<table>
<tr><td colspan="2">Name of Study:
***Compañó, R., Pascu, C., Burgelman, J.C., Rader, M., Saracco, R., Spinelli, G., Dachs, B., Weber, M., Mahroum, S., Popper, R., Green, L., Miles, I.* (2006):** Foresight on Information Society Technologies in the European Research Area (FISTERA) – Key Findings. Luxembourg: Office for Official Publications of the European Community. EUR 22319 EN.</td></tr>
<tr><td>Promoter/Initiator</td><td>European Commission, Directorate-General Information Society.</td></tr>
<tr><td>Agency or organisation responsible for activity/research</td><td>European Commission, Directorate-General Joint Research Centre, Institute for Prospective Technological Studies (IPTS), Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Institut für Technikfolgenabschätzung und Systemanalyse (ITAS), Telecom Italia TILAB, Austrian Research Centres, Systems Research, Victoria University of Manchester, Programme of Research on Engineering, Science and Technology (PREST), GOPA-Cartermill (administrator) plus members in 14 EU member states.</td></tr>
<tr><td>Scope/areas covered</td><td>Information Science Technologies, with work packages on existing foresight, a database on information science technologies, an assessment of Europe's position in the world and "futures forum" activities (an on-line Delphi and a series of workshops).</td></tr>
<tr><td>Time horizon</td><td>Mainly short-to-mid-term future (2010), but partly beyond.</td></tr>
<tr><td>Dimensions addressed in study</td><td>Technologies, Innovation, Applications, Socio-economic conditions.</td></tr>
<tr><td>Objectives of the document</td><td>FISTERA had the aim of taking first steps toward the creation of a foresight platform for discussing and developing a European vision for the future of IST.</td></tr>
<tr><td>Target groups</td><td>Policy makers at EU level and all levels of government in the EU member states, industry, other stakeholders.</td></tr>
<tr><td>Methodology</td><td>Analysis of documents, database using broad input, patent and publications analysis, on-line Delphi study, workshops, scenario techniques.</td></tr>
<tr><td>Participation</td><td>A total of 600 experts participated in one way or another in the activities for the project</td></tr>
<tr><td>Major characteristics</td><td>Combination of top-down and bottom-up approaches for the setting of IST priorities. Top-down approach starts from a realistically achievable "success scenario" for the European information society.</td></tr>
<tr><td>How have ICTs been included and treated in the study?</td><td>Main topic of the report.</td></tr>
<tr><td colspan="2">**Main Results**:
The report has a section on European strengths, weaknesses, opportunities and threats, as perceived both within EU Member States and by states outside the EU. Important factors in this context are the availability of sufficiently skilled labour and a well developed educational system. Europe has many advantages to make it attractive as a location for R&D work.</td></tr>
</table>

The top science and technology priorities are:

- technologies at the crossroads of ICT with nanotechnology, biotechnology and the cognitive sciences ("converging applications);
- technologies enabling the transition from products to services;
- technologies striving at offering "unlimited bandwidth" and terminals as network infrastructure;
- embedded systems;
- technologies favouring the disappearance of computers.

While foresight exercises tended to highlight "security" as an important topic, the FISTERA Delphi revealed a far lower significance of the issue, indicating that "some technology experts have *probably overestimated the role and impact of ICT for security* in the aftermath of the terrorist attacks" (p.3).

Following the dip due to the bursting of the Internet bubble, economists feel "that society is on the brink of entering the second deployment phase of ICT applications" (p.4).

There is widespread consensus across European societies that there is a need to move toward a knowledge-based society and economy.

EU Member States are still more inward-looking with respect to technology policy than looking toward developing strategies and visions for Europe as a whole.

The "success scenario" includes such elements as need for increased mobility and the development of consumers into "co-developers" or prosumers.

Priority areas for applications are:

- Enhancing relationships and communication,
- Supporting an ageing population and health-care related applications,
- Maintaining European diversity of languages, cultures and lifestyles,
- Contributing to community learning and planning processes,
- Enhancing "governmental efficiency".

The five (sic, actually six!) biggest challenges are:

- Privacy and trust
- Security and robustness
- Ethical concerns
- Digital divide
- Infrastructure and investment gaps
- Social innovation and IT literacy

The FISTERA database revealed seven key technologies with an "attraction" pattern i.e. technologies having major influence on the development path of other technologies. These are:

- Embedded systems
- Micro-kernels
- ad-hoc protocols
- Technologies offering more bandwidth
- Technologies providing greater storage capacity
- Information semantics
- Radio Propagation

Apart from the major trends already mentioned, the following are significant:

- Ubiquitous, seamless connectivity
- The availability of reliable and robust autonomous systems
- The emergence of virtual infrastructures
- The move from content to packaging.

Big European ICT companies are highly competitive worldwide, but Europe seems to lack medium-sized ICT companies.

High-risk research in public research institutes is less pronounced than could be expected (e.g. ICT-Bio convergence)

Name of Study: ***Holtmannspötter, D., Rijkers-Defrasne, S., Glauner C., Korte, S., Zweck, A****:* Übersichtsstudie Aktuelle Technologieprognosen im internationalen Vergleich, June 2006	
Promoter/Initiator	Federal Ministry of Education and Research, Germany
Agency or organisation responsible for activity/research	Zukünftige Technologien Consulting der VDI Technologiezentrum GmbH, Düsseldorf
Scope/areas covered	The study focuses on the national innovation systems (NIS) of eight countries (China, Denmark, India, South Africa, South Korea, the UK and the US). It compares the profiles of technology prognoses prepared for each of the countries concerned and then the individual prognoses per country across technology areas common to the studies.
Time horizon	Varies across countries covered in the studies (up to 2035, UK)
Dimensions addressed in study	Mainly technologies possessing high priority or of major interest, addressing anticipated period for realisation of technology.
Objectives of the document	To present in a compact and concise form selected information from international technology prognoses and their impact for the development of strategies by the Federal Ministry of Education and Research and other agencies.
Target groups	Political and industrial policy-makers.
Methodology	Employs uniform template for the analysis of studies.
Participation	None, desk work only.
Major characteristics	Detailed overview of each NIS, followed by detailed analysis of each study across the whole range of technologies. Two cross-study sections with tables on each study, comparison of assessments of technological fields common to studies.
How have ICTs been included and treated in the study?	One field of sixteen. Other ICT relevant fields include electronics, health and medical technologies, services (South Africa only).
Main Results China particularly highlights technologies for the safety of information and the safety of networks; special equipment for the manufacture of integrated circuits (<45 nm); development and manufacture of 64-bit multipurpose high performance CPU chips. Denmark: ubiquitous computing; nano optics, nano-photonics Canada: Basic right of access to the information infrastructure; sensor network as basis for a platform for reactions to emergencies; continued validity of Moore's law; substitution of travel by telepresence (2025). South Africa: Mobile technologies and devices, wireless networks, language technologies; in the services area, the report mentions mobile, wireless technologies for tourism and language technologies for tourism. South Korea: biometric recognition systems to automatically and unobtrusively identify persons	

(by 2012); Devices for video-conferences with the function of automatic translation commercially available (2015); ICT supported applications in transport and logistics.

UK: trust in cyberspace, applications of biologically inspired complex adaptive systems; visual security techniques; hybrid optical data networks (by 2012).

US. Magnetic data storage with 50 $Tbit/in^2$ (2013); unmanned autonomous combat vehicles; sensors for protection against terrorist attacks with bio-weapons; white light LED with 150 lm/W (2015).

The study contains a core statement on ICTs: “It is to be expected that there will be a diffusion of large-area computer and sensor networks. The sensor networks provide data which can, for example, be employed to monitor hazards to the environment and health, and also in connection with comprehensive modelling of the environment.”(p. 202). This theme is particularly prominent in the studies from Denmark, Canada, South Korea, and, to a lesser extent, the UK.

Name of Study ***CMI International, ICTAF, VTT, Z-Punkt, North Carolina State University, Institute for Industrial Interchange (2006):*** Emerging Science and Technology priorities in public research policies in the EU, the US and Japan	
Promoter/Initiator	European Commission, DG Research, Directorate K, Unit K2. Foresight knowledge sharing activity.
Agency or organisation responsible for activity/research	Consortium consisting of CMI International (France), ICTAF Israel), VTT (Finland) and Z Punkt (Germany) plus North Carolina State University and the Institute for Industrial Interchange (Tokyo).
Scope/areas covered	The study covers four fields of technology: Nanotechnologies and new materials; information society technologies; life science, technologies for sustainable development.
Time horizon	2015 – 2030 and after.
Dimensions addressed in study	- Expected date of maturity of emerging S&T priorities - Potential impact of technologies on science and technology, industry and business, the environment, quality of life. - Public policy support and main drivers - Scientific positioning of Europe
Objectives of the document	Analysis of emerging science and technology priorities in public research policies of the European Countries, the US and Japan and their relation to priorities to actual S&T developments and their economic and social rationales.
Target groups	EU policy makers at all levels.
Methodology	Questionnaire survey among 1300 experts throughout the enlarged EU. 2/3 of the experts were from public research, 1/3 from the private sector. In parallel analysis of more than 110 foresight reports. A list of 104 candidate technologies, selected from the literature by a panel of 300 experts, was used for the survey. From these, a short list of 40 technologies was drawn up as the main priorities for the future. 12 of these are Information Society Technologies.
Participation	300+ experts to select 104 candidates from literature, 1300 experts to draw up short list of 40.
Major characteristics	Two-tier expert survey, literature survey.
How have ICTs been included and treated in the study?	ICTs were one of four areas of technology examined for potential S&T priorities
Main Results In IST, Europe has a less important scientific position than the US and Japan. With respect to the efficiency of public policy support, Europe is in at least as good a position as the US, but the US spends twice the amount that Europe does. Japan is comparable in terms of spending, but seems to be more efficient in its use of funds. Europe puts stronger emphasis than the US or Japan on societal factors (Europe supports IST, the US and Japan ICT). Either Europe has a weak industrial base in the area, or the links between basic R&D and application development in industry are weak. Europe has particular strengths in 4G mobile communications and also relatively well-positioned in embedded single-chip applications, microsensors and nanosensors,	

software technologies for the transport of digital data and individualised health services and drugs. The latter also receives a particularly high level of public non-financial support, while an item “advanced technologies for virtual/augmented reality receives only weak support.

The 12 areas of ICT selected as important were:

- Software technologies for transport of digital data
- Broadband network (advanced optical communication, Multiprotocol label switching, IP/WDM.)
- Mobile communications (4G)
- Advanced technologies for virtual reality/augmented reality
- Computer-aided surgery
- Individualised health services and drugs
- Advanced data mining technologies and high performance data storage systems (e.g. intelligent systems for decision-making, computer modelling and design of systems and processes).
- Embedded single-chip applications
- Multipurpose intelligent and mobile robots
- Image sensors (robot perceptive systems, image processing)
- Intelligent artificial limbs
- Microsensors and nanosensors

In terms of priority, the software technologies for data transport were the second most important technology of the 40 on the shortlist. Five other technologies occupied ranks 10 – 14 of the priorities (items 6, 5, 2, 7 and 3 of the list above). The advanced technologies for VR/AR were ranked at 17, the microsensors and nanosensors at 25, image sensors at 30, embedded single-chip applications at 31, intelligent artificial limbs at 34 and multipurpose robots at 35.

Name of Study ***Hundley, R.O., Anderson, R.A., Bikson, T.K., Botterman, M., Cave, J., Neu, C.R., Norgate, M., Cordes, R. (2001):*** The Future of the Information Revolution in Europe: Proceedings of an International Conference. Santa Monica: RAND	
Promoter/Initiator	National Intelligence Council, co-sponsored by the Defence Evaluation and Research Agency (DERA), United Kingdom, and the International Relations and Security Network, Switzerland.
Agency or organisation responsible for activity/research	RAND National Defense Research Institute, Acquisition and Technology Policy Center. RAND Europe.
Scope/areas covered	The "Information Revolution" from the European perspective.
Time horizon	10-20 years (c. 2015).
Dimensions addressed in study	Differences in the perception of the "Information Revolution" in Europe and elsewhere.
Objectives of the document	To expose the American-centric picture of the information revolution developed by previous RAND conferences to an informed European audience. Deepen understanding of the course of the information revolution in Europe and elsewhere in the world.
Target groups	Mainly US policy makers.
Methodology	Conference held in Limelette (Belgium) in April 2001. Proceedings prepared by a group representing the organisers.
Participation	About 50 experts including the organisers.
Major characteristics	Conference with prepared presentations on a "virtual conference" followed by structured discussions. Breakout groups on selected topics.
How have ICTs been included and treated in the study?	There were sessions on the technology, economic and business, social, governmental and political, and security dimensions of the Information Revolution. There is a special section on variations in the Information Revolution across Europe, followed by a section on differences between the US and Europe. The proceedings also list unanswered or incompletely answered questions worth addressing in the future.
Main Results - The European view of the information revolution is similar to that of the US, but not identical. Europeans places more emphasis on wireless technology. - The social, political and economic "climate" differs in important ways from that of America. - Economic and social change comes easier in the US than it does in Europe: Europeans are on average more risk-averse than Americans. The European financial sector is less supportive than that of the US of small start-up companies. - Europeans place more value on equality of outcomes than US Americans (incompatible with risk-taking mentality). - European desire for convergence among the countries of Europe (US wishes to "get ahead"). - Different notion of the balance of power between market forces and government	

intervention.
- Greater European emphasis on top-down planning (less market-driven).
- Greater European emphasis on sustainability (in economic and environmental terms).
- Process of “creative destruction” likely to be slower in Europe than in the US.

Aggressive pursuit of IT-related business opportunities in the US, more subdued in Europe due to concerns about equity.

Top-down planning also decelerates developments.

Europeans tend to try to assess consequences of innovations whereas US tries and sees what happens.

It is to be expected that Europe will be forced to become more like America. On the other hand, there are arguments that there is no single European approach to preserving social equality and that some countries might be able to resist pressure to loosen their own approach.

IT security has to cope with the problem of conflicting desires for security, privacy, openness and functionality.

International laws on activities in cyberspace are currently incompatible. There is the problem of adapting regulation to existing practice (law usually lags behind real life).

There is also a conflict between policing (to prevent abuse) and privacy.

Security-awareness among users is limited. It is possibly time for data protection to become an essential legal requirement.

Europe has to trust US-built information systems, simultaneously being dependent on them. There is suspicion that “back doors” are built into systems to allow the US government or commercial undertaking to collect intelligence.

Topics meriting further discussion or investigation:
- Variations across Europe;
- The European view of the US as part of the “dark side” of the Information revolution.
- Secrets of success for a nation in the Information Age;
- Privacy: differences between the US and Europe, need to adopt common standards;
- Views of younger Europeans;
- Views of Non-EU Europeans;
- Drivers of technological and economic change;
- Role of European (or traditionally European-based) companies in the global economy; European financial markets (nature of differences to US);
- Tax and regulatory policies;
- Europe’s growth prospects (balance within Europe, relation to US and Asia);
- Impact of defence spending;
- Corporate governance and ownership of shares (differences to the US);
- WTO and export controls.

Name of Study: ***Silberglitt, R., Antón, P.S., Howell, D. R., Wong, A. (2006)***: The Global Technology Revolution 2020, In-Depth Analyses: Bio/Nano/Materials/Information Trends, Barriers and Social Implications. Santa Monica: Rand	
Promoter/Initiator	National Intelligence Council, USA.
Agency or organisation responsible for activity/research	RAND National Security Research Division
Scope/areas covered	Bio/Nano/Materials/Information technologies. 56 illustrative technology applications, with special emphasis on 16 scoring the highest ranking for a combined assessment of technical feasibility on a commercial basis, potential marketability and the number of societal sectors influenced for 29 representative countries.
Time horizon	The period until 2020 (15 years).
Dimensions addressed in study	Technology trends, including their cross-country variations.
Objectives of the document	Elucidation of the factors influencing the potential of the technology revolution in different countries and drawing inferences about the future of the technology revolution. The report is basically an update of a previous RAND study: The Global Technology Revolution: Bio/Nano/Materials Trends and their Synergies with Information Technology by 2015 (2001) (GTR2015).
Target groups	Primarily the national intelligence council. The 2020 Project has the aim of providing US policymakers with a view of how world developments could evolve, identifying opportunities and potentially negative developments that might warrant policy action.
Methodology	The report examines progress made on the trends identified in the previous report (GTR 2015), identifies new trends, but also uses the description of potential applications to convey to the non-scientist the kinds of potential effects expected to result from these trends. Review of major scientific journals and magazines, assessing the viability of projected technology trends, based on degree to which real progress is being made in the R&D laboratories, the degree of interest and investments in these trends, and expert judgement on the likelihood of applications having a significant impact on major global demand sectors and policy drivers (cf. p. 5). The report includes background papers analysing likely technology trends. One of these is on "Information Technology Trends to 2020" (by *Elaine M. Newton and Shari Lawrence Pfleeger*)
Participation	All reports appear to have been prepared by RAND experts. There seem to have been no expert workshops or conferences for this report.
Major characteristics	The study was designed to inform the NIC's 2020 project, which is concerned with the global future in general.

How have ICTs been included and treated in the study?	The annex on IT Trends discusses the following trends: - Convergence of technologies - Growth in volume and types of personal data and Global Positioning System (GPS) with subsequent database issues - Smaller mobile electronics devices.

Main Results

Convergence of technologies and functionality will continue to be a theme of mainstream digital products, facilitated by developments in wiring and materials to carry digital information, possibly optical circuits. There is the possibility of bundling telephony, television, cable, radio, PCs, Internet access, power, day planners and room lighting into a single product supplied by one vendor. Clothing and computing will converge in smart clothing, wearable computers and video lenses. Particular issues will be privacy and data security, regulation of previously separate functions in a merged form.

By 2020 relatively simple sensors, such as RFID, and smarter sensors with an amount of information and the ability to communicate with each other, will be widely deployed. The power issue for these smart sensors is still unresolved.

The use of biometrics across a range of applications is likely. The technology employed will vary according to application, e.g. Internet and e-Commerce (fingerprints, keystrokes, iris, face scan), law enforcement, national ID documents, PC access, voter registration, banking. There is definitely a push towards biometrics, there are unresolved issues making application uncertain (e.g. reliability, standardisation, privacy and security concerns, linking data)

Cameras are getting smaller and embedded in everyday objects like phones and badges. Memory for storage is abundant and cheap. There has been a need to regulate the use of these cameras in public places (courtrooms, gymnasiums). By 2020, development will have progressed much further (data transmission speeds, miniaturization) –image and video data could be used for identification, authentication and analysis. Use in security and crime-related applications will be associated with privacy and anonymity threats.

The use of GPS in hardware will increase, again posing threats to privacy and anonymity, especially through the ability to track individuals.

Database technology is gaining importance. Databases will be updated often and will require additional contextual information to describe the nature of the data contained in them. There will possibly be a move to large, centralized databases. By 2020, there will most likely be *agile databases,* partitioned or reconfigured databases which have extracted the data required from large, centralized databases. Since extreme cases, or outliers, are the most interesting data in databases, there might be social pressure to "be like everybody else" to avoid unnecessary scrutiny. However, there is also the wish to distinguish oneself from other people (e.g. by personalised ringtones), so data-mining techniques used to customise recommendations may be helpful in working against uniformity.

Electronic devices are becoming smaller, more lightweight and often wireless and mobile. This trend creates a particular need for alternative power sources that are lightweight, mobile and long-lasting. High performance computing could move towards clusters of smaller, cheaper machines, which are "agile" and reconfigurable according to needs. A buzzword is "opportunistic IT" – the application of the swarm metaphor to networks and applications.

There is increased interest of researchers on ways to protect and assure privacy. "With the right set of research and/or regulatory incentives, IT researchers and developers can create technology that embraces cultural norms and preferences for privacy and/or anonymity." (p. 186)

By 2020, due to advances in electroactive polymers and biomedical engineering it is likely that there will be robots that look and behave much like humans. This development will be further enhanced by the availability of suitable sensors, cameras and microphones. It is conceivable that robots can be used as proxies (proxy-bots or proxy droids), which allow persons to be in multiple places simultaneously. Signals would be transmitted from the human brain to control plastic muscles or vocal chords.

Formal and informal education could make use of tools developed to scan light beams to the retina, creating a layer over what would be normally seen with the naked eye. This technology could be used to give directions, label parts, explain how to fix a device etc. Use of the Internet would free teaching of time and location restraints: “A more mutable type of college degree could result, not affiliated with a university but instead resting on the reputation of the professors whose courses were purchased and passed” (p. 187).

Neural engineering and implants could find use to help people with physical disabilities or ailments. Examples are auditory images for the blind to see through different noises. There are also expected to be IT devices to help control bodily functions (insulin monitors etc.) and prostheses.

By 2020, there will be more emphasis on customisation of items such as clothing or vases, there will be printing on demand – books will be ordered online and be produced in response to order.

Technology development will continue at a rapid pace over the period until 2020;

There will be major differences in the impact of the “technology revolution” across different countries;

Technologically lagging countries are expected to encounter challenges in institutional, human and physical capacities;

Advanced countries will stay ahead only if laws, public opinion and other social factors “do not become impediments” (Key findings in the “Research Brief”;

Some technology applications will trigger strong reactions over religious, environmental or social concerns.

Public policy issues will need to be debated in an environment that seeks to resolve conflicts.

Western Europe, with North America and East Asia, belongs to the technologically pre-eminent regions of the world.

The technologically proficient countries of Eastern Europe, typified by Poland, are rising as technological powers along with China and India.

Among the technology applications considered most important in the study are:

- Rural wireless communications
- Ubiquitous radio-frequency identification tagging of products and people (RFID)
- Quantum-mechanical cryptography for secure information transfer
- Communication devices for ubiquitous information access
- Pervasive sensors
- Computers embedded in clothing and other wearable items.

II. National Foresight Studies

Name of Study: *National Research Centre for Science and Technology for Development, Research Group of Technology Foresight(2005):* China's Report of Technology Foresight (Summary), Beijing, September 2005	
Promoter/Initiator	Ministry of Science and Technology, Department of Development Planning. People's Republic of China.
Agency or organisation responsible for activity/research	National Research Centre for Science and Technology for Development, Research Group of Technology Foresight.
Scope/areas covered	483 items across six fields: information, biotechnology, new materials, energy, resources and environment, advance manufacturing.
Time horizon	2006 to 2020
Dimensions addressed in study	Technological importance, economic benefits, impact on high-tech industries, impact on traditional industries, environment protection and utilization of resources, quality of people's life; realization time; assessment of position of China (ahead, same level behind by …years)
Objectives of the document	Identification of critical technologies in the six fields with great significance for China's social and economic development.
Target groups	Ministry of Science and Technology, for national medium- to long-term planning, probably also Chinese industry.
Methodology	Classical 2- round Delphi study
Participation	A total of 2725 questionnaires were sent out in the first round, 2476 in the second. Response consisted of 1096 (40.2%) in round 1, and 929 (37.5%) in round 2. Questionnaires on information technology were sent to 600 persons in round 1, but only 350 persons in round 2. 328 responses (54.7%) were received in round 1, 183 (52.3%) in round 2. These were the highest response rates for any of the six fields of technology.
Major characteristics	Classical technology Delphi with only minor attention given to socio-economic aspects.
How have ICTs been included and treated in the study?	One of the six technology fields considered in the study. In the first round, 80 of 479 items were from the information field, in the second 75 out of 483.
Main Results Of the 483 topics described in items in the questionnaire, China is only leading or at "world" level for 21 topics. Of these 21, 6 are in the information field, but China is considered as lagging behind the world leaders for another 69 topics, by over 5 years in 3 of these. A majority claims that China is leading the world in "Chinese Information Technology". It is at world-level for TD-SCDMA and Enhanced 3-G technology. Of the 100 most important items, 26 are from the information field, including the four most important: information security technology, network security technology, super-computer system design, and research in Next-Generation Network Architecture. A further four items are still I the top ten: Chinese information processing technology, operating system of network computing environment, development of new and popular integrated circuit products, research	

and manufacturing of 64-bite high-performance general-purpose CPU chips.
Other interesting items are SoC design, Ipv6 technology, next generation Internet, broadband access technology.

The items in the information field considered to have the greatest economic benefits are:
- Metropolitan Area Networks as a business services delivery platform,
- Broadband Access Technology;
- Software technology for enterprise informatization
- Code conversion technology for digital TV
- Operating system for network computing environments.

The items likely to have greatest impact on high-tech industries are:
- Development of new and popular IC products,
- Research and manufacture of embedded microprocessors
- SoC design platform and SIP reuse technology
- TD-SCDMA and enhanced 3G technology
- Research on next generation network architecture
- The items likely to have the greatest impact on traditional industries:
- Research and manufacture of embedded microprocessors
- Development of new and popular IC products
- Software technology in enterprise informatization
- SoC design platform and SIP reuse technology
- New technology of embedded software.

Items likely to have the greatest impact on protection of the environment and utilization of resources.
- Life Science and Information Processing in the biotechnology field
- Information network
- Software technology for the informatization in Enterprise
- Software technology for the informatization of Society
- New Super Computer Design

Finally, the items likely to have greatest impact on people's quality of life:
- Chinese information processing technology
- Broad band access technology
- New and hot integrated circuit production exploitation
- Research for digital interaction TV and terminals
- New software technology in mobile computing environments

With biotechnology, information technology items have the greatest overall importance in the Delphi study and are expected to be realised within the shortest timeframe.
Over all, the most important tasks for government according to the respondents were "strengthening the cultivation of talents" (i.e. education and training) and increasing research input. The next most important task was strengthening cooperation between industries, academia and R&D institutions.

Name of Study: ***S.P. Gupta (chair) and Commission on Vision 2020 (2002)***: India Vision 2020, New Delhi December 2002	
Promoter/Initiator	Planning Commission, Government of India
Agency or organisation responsible for activity/research	Commission on Vision 2020, consisting of over 30 experts from different fields, chaired by Dr. S.P. Gupta.
Scope/areas covered	Comprehensive overview of India's future, focussing on job generation, education, population growth, transport, communication, energy supply, water conservation and air quality, trade investment, peace, security and governance.
Time horizon	2002 to 2020.
Dimensions addressed in study	Human development, infrastructure, energy and the environment, globalisation, peace and security, governance. The report includes a "best-case scenario for India in 2020 and "decision points", i.e. key findings on factors determining the future of India.
Objectives of the document	To prepare an outlook for India in 2020, especially focusing on opportunities and challenges. To envision the possibilities of India's development potential over the next two decades within the multidimensional framework outlined above. To seek inputs from members of the committee and other experts or outside sources, and to produce the present document.
Target groups	Government and private sector decision-makers.
Methodology	Expert commission, some consultation of external experts and other sources. The foreword acknowledges a book: Kalam, A.P.J.A: India 2020: A Vision for the New Millennium, Penguin of India 1998.
Participation	Only experts.
Major characteristics	Report based on many notes and papers, produced over the two years of existence of the commission. Some reference to 2020 reports produced elsewhere.
How have ICTs been included and treated in the study?	Knowledge and Information Technology are treated in a chapter headed "Uncommon Opportunities". Rapid flow of information is described as a "catalyst for social development" (p. 8). Vision 2020 sees India developing into an information society and knowledge economy, built on the edifice of ICTs, "of which telecommunications is the springboard" (p.8). Rapid expansion and extension of the country's fixed and mobile communications infrastructure are essential as stimulant for ICT sector and economy as a whole. 3G should be available to wide sections of the public by 2020. IT is dealt with as a pervasive factor under different headings, such as education, employment, infrastructure and governance.

Main Results
The report notes that computerisation coupled with low-cost global telecommunications is enabling trade in service businesses, notably software and IT enabled services. This is opening up vast opportunities for countries with the capacity to deliver low-cost, high-quality service. At the same time, the pressure for the export of highly educated and highly skilled individuals will increase, resulting in continued migration of scientific, engineering and medical talent.

Among the major challenges for India is investment in telecommunications infrastructure.

India's service sector at the time of the study, accounted for 46% of GDP. The report anticipates that India will be able to leapfrog into a predominantly service economy by 2020, "creating services that meet human needs, generate employment covering the large unorganised segment of the economy, rais(ing) incomes and increase(ing) purchasing power". (p.22)

India is undergoing an "IT revolution", which is "a striking instance of how the importance of human capital has come to acquire a higher position than that of material plant and machinery" (p. 23).

The report includes the vision of India as a "superpower in knowledge" (p.24). It states that "far greater potential lies in the extension and application of IT to stimulate the development of other sectors of the domestic economy" (p.24), also IT can vastly extend access to education, health care, markets etc.

There is a need to create many new jobs and most of these will be in the "unorganised sector", including SMEs. Among the high employment potential sectors identified in the report are IT&IT enabled services, communications. By far the largest number of new jobs is expected to be in the services sector. For India, the promising categories include computer-related research, telecommunications, audiovisual, wholesale and retail distribution, education at all levels etc.

Examples of IT-enabled service businesses in India are call centres, medical transcription, technical support and back office processing, engineering and design, geographic information services, payroll and other human resource services, insurance claim processing, legal databases. Teleworking is just beginning in India, providing opportunities for educated women with children.

India is well-poised to become a world-leader in the management of information of all types.

Television is an effective means of education; computer and Internet-based educational methods have transformation potential for concepts of the school and classrooms. The traditional boundaries between education and other sectors will fade: publishers, non-profit and for-profit enterprises will enter education – classroom type of education will no longer be the predominant model. In view of anticipated shortages of educators, there is a need for India to embark on "a massive programme to convert the entire higher educational curriculum into a multi-media, web-based format and to establish accreditation standards for recognition of the distance education so imparted" (p.47). The report recommends doubling spending on education with the hope of quadrupling per capita GDP.

There is a need to upgrade the country's 500 engineering colleges. Expenditure on R&D is very low, even the number of scientists is low compared to the absolute size of the population. There is great potential for growth of an Indian R&D industry in IT, but also biotechnology, pharmaceuticals, designer-made materials etc.

There is a need for a comprehensive strategy to enhance India's employable skills, again involving television and computerised training. The recommendations include a network of 50,000 computerised vocational centres run as private, self-employed businesses, similar to STD booths and Internet cafés to deliver low-cost, high-quality training to 10 million workers very year. This is five times the number covered by existing programmes.

Telecoms are characterised by rapid extension of direct exchange lines, continued shortage of such lines and reduction in telecom rates. Cellular telephony has "unleashed dynamism", improving telecom penetration in the population. Even so "India's tele-density remains appallingly low" (p. 63). One measure are "public call offices" and Internet kiosks. The report calls for transition to digital switching and transmission, VoIP, broadband and 3G by 2020.

Among the most important technological breakthrough anticipated globally until 2020 are:
- Portable information devices
- Robotics
- Computerised health care
- Application of computers will spread, especially in communication, manufacturing, finance and trade, scientific research, education and medicine.
- The cost of global communications will continue to decline rapidly.

India has a good position in the export of services, e.g. software and IT enabled services. India already has 18.5% of the global market for customised software and the Indian software industry is the fastest growing in the world. India can fall on the credentials established in this field to expand into other branches of engineering, branches of scientific research (e.g. biotechnology, medicine, pharmaceuticals, education).
The best-case scenario for India in 2020 includes a statement: "India's claim to the title Silicon Valley of Asia will be followed by the diversification from IT to biotechnology, medical services and other emerging fields of technology…" (p.92). Also: "Computerisation of education will dramatically improve the quality of instruction and the pace of learning, so that many students will complete the first twelve years of school curriculum in eight…Computerisation in government will streamline procedures and response times to a degree unimaginable now. Perceptive observers will find that India is leapfrogging directly into a predominantly service economy" (p.93).

The report concludes with a list of 9 "Nodal Points of Indian Prosperity". These include:
- KNOWLEDGE – 100 per cent literacy & school education, and vocational training for all new entrants to the workforce, to equip youth with the knowledge and skills needed to thrive in an increasingly competitive world: adult education programmes to compensate working age school drop-outs for the lack of education, and continued investment in science and technology to improve productivity, quality of life and the environment.
- TECHNOLOGY & INFRASTRUCTURE – Continuous expansion of the physical infrastructure for rapid low-cost transportation and communication that is required for rapid economic growth and international competitiveness. Application of computers to improve access to knowledge and information, and increase in the speed, efficiency and convenience of activities in all fields of life.

Name of Study: ***NISTEP – The National Institute of Science and Technology Policy (2005):*** Eighth National Japanese Science and Technology Foresight (2035). Tokyo: NISTEP	
Promoter/Initiator	MEXT – Japanese Ministry of Education, Culture, Sports, Science and technology; The Science and Technology Council of Japan.
Agency or organisation responsible for activity/research	NISTEP – The National Institute of Science and Technology Policy
Scope/areas covered	13 Delphi fields: information/communications; electronics; life science; health/medical care/welfare; agriculture/forestry/fisheries/foods; frontier; energy/resources; environment; nanotechnology/materials; Manufacturing: industrial infrastructure; social infrastructure; social technology.
Time horizon	Until 2035.
Dimensions addressed in study	• Demand for new technologies • Bibliometric study on rapidly developing technologies • Scenario development • Comprehensive Delphi Study In contrast to previous studies, the eight foresight study puts more emphasis on societal and economic demand.
Objectives of the document	To serve as input for policy making on the new Science and Technology Basic Plan. The study took place earlier than its predecessors in order to be completed in time for national programme development.
Target groups	Mainly policy-makers, but also “all interested parties”.
Impact	Still too early to evaluate, but there is assumed to be major impact on the S&T basic plan. The government is said to be improving the framework conditions for the development of fields considered to be of particular relevance for Japan. The activities involved many of the key players in the fields concerned (scientists, technologists, industry) who bring their knowledge into the foresight process and also profit from insights gained by participation.
Methodology	• Needs survey based on interviews, a survey and a workshop • 2. Bibliometric survey, analysis of citation index, mapping technique leading to 51 rapidly developing technology fields regarded as possible priority areas for future Japanese S&T research. • Set of 48 scenarios, consisting of 1-page normative descriptions accompanied by longer texts with recommendations on ways to achieve the scenarios in practice. • Comprehensive two-round Delphi survey.
Participation	A few hundred experts were involved in the first three activities, including more than 200 experts across the 13 fields preparing the Delphi questionnaire. In the first round of the survey 4219 questionnaires were sent out, of which 2659 were returned completed. In the second round, 2239 were sent out, of which 84% were returned.

Major characteristics	Core is Delphi with additional elements added to give better coverage to societal and economic aspects.
How have ICTs been included and treated in the study?	Information and communications technologies have made the most rapid technological advances of any field over the past half-century. They have also provided the basis for the development of other technological fields. Applications of ICTs were partly covered in other fields of the Delphi survey and the field of ICT itself was confined to “general” ICT. The topics include making the technology more advanced and larger in scale, interfaces easy for people to use, making use more secure, broader use of ICT. Topics covered: Very large scale information processing; High-productivity computing; Human support (intellectual support); Ultra-transparent communications (space sharing)/ human interface (muscular strength support); Information security; Information technology for developing social systems; New principles for information and telecommunications; Ubiquitous networking; Software technology for large-scale network. Each item is ranked for its potential contribution to the following aspects: • Increased intellectual assets • Development of other fields • Existing Japanese industry • New businesses and industries • Safety and security • Social vitality and quality of life Additionally, each item is ranked for its degree of importance to Japan, time of technological realization, countries at the leading edge (US, Japan, EU, other Asian countries), need for government involvement, measures to be taken by government, questions with respect to social application, measures to be taken by government to facilitate social application.

Main Results

Over all in ICT, Japan is trailing behind the US, but ahead of Europe. In the fields of electronics, the lead of the US over Japan is smaller. Over all topics, the US leads Japan and Europe, with Europe trailing significantly behind Japan in all fields.

The most important topics were Large-scale integration and wearable equipment (cf. EFMN Brief no. 035) and topics related to security in networks and viruses. The report itself states: “This can be seen as reflecting society’s current anxiety and social demand for greater safety” (p.95).

According to the report, the field of ICT has made the most rapid technological advances of any field over the past half-century.

ICT requires integration and collaboration with many and diverse fields. ICT is expected to continue to increase productivity and to contribute to building a safe and secure society. Many of the “social technology” items considered in the foresight study are “reactive”, only a few "formative".

There is a general feeling that the spread of ICT has formed a "new society", leading to a reformed regulatory system. Resistance to reform is expected from businesses whose profits could be harmed: rule change takes time, and this can damage international competitiveness. A case in point is copyright, where resistance to change is coming from distributors of creative content. Other issues requiring regulatory attention are remote medical care and cross-media services.

The most important ICT-related topics are:

- A highly reliable network system capable of protecting the privacy and secrecy of individuals and groups from intrusion by malicious hackers – expected to be technologically realised by 2012, socially applied by 2016.
- Technology to ensure safety of human life from earthquakes (early detection of seismic waves through a sensor system based on home management and security systems – expected to be technologically realised by 2012 and socially applied by 2020.
- Technology to detect intrusions and viruses on the Internet backbone - expected to be technologically realised by 2009 and socially applied by 2013.
- Capability to trace back the source address of suspect packets on the Internet to detect intrusions - expected to be technologically realised by 2009 and socially applied by 2013.
- Forecasts of diseases and disasters through advanced modelling and simulation technologies for large-scale environmental or other systems - expected to be technologically realised by 2015 and socially applied by 2023.

The sixth ranked item was also related to system security, the seventh and eighth to health applications, the ninth to traceability of foods, and the tenth to multimedia: "The emergence of equipment, including a software modem, that supports almost all media such as digital broadcasting, high-speed mobile communications, wireless LANs, and wired access leads to the widespread use of cross-media services, which allow for concurrent access to multiple media and automatically choose the optimum medium for the situation, to control and coordinate home gateways in households" (item no. 04, cf. report p. 99).

While certain items were regarded as realisable within a reasonably short period of time, such as spam-free software (2009) or a system permitting seamless wireless communications (2010) in addition to examples already mentioned, there were some items, whose realisability lies in the fairly distant future, e.g. expert systems in professional domains capable of carrying out roughly half the tasks of a human expert (2018); a "sensibility expression system that can, when given a description of a certain image, present music and pictures suited to the person's sensibilities" is, however, expected by 2015. Use of nanochips in medical applications (e.g. monitoring of bodily functions) is not expected before 2020.

The report includes a timeline for the items included in the questionnaire. Among the remotest visions are technology to read the human brain (2027), a system for communication with humans in the deep sea or underground based on new principles (high frequency oscillatory or gravitational waves) (2027); mind-machine interfaces based on brain waves (2030); general purpose quantum computing applicable to diverse algorithms (2030) or the discovery of a mechanism for the human brain to directly receive a greater amount of information faster by means of a system other than the visual or auditory systems (2031). The application of such breakthroughs is expected rather later (5 to 7 years)

Name of Study: ***Institute for the Future, Stanford CA (2005-2006):*** Delta Scan: The Future of Science and Technology	
Promoter/Initiator	UK Foresight Programme: Horizon Scanning Centre, UK Government Office of Science and Innovation
Agency or organisation responsible for activity/research	Institute for the Future, Stanford CA.
Time horizon	2005-2055
Objectives of the document	Part of the UK Foresight programme's horizon scanning activities to provide early warning.
Target groups	Industry, political decision-makers, other actors involved in UK foresight.
Methodology	Probably mainly desk research.
Participation	Restricted to few experts.
Title of brief	**Simulation as a method of quantitative analysis**
Main results Computer simulations making it easier for the social sciences and psychology to use a greater range of information and explore more alternatives than in the past. Increased computing power and storage capacity mean that the sizes of datasets and numbers of variables can increase immensely. The big challenge is to develop statistical techniques for finding meaningful patterns in immense datasets. The implications include: • Better understanding of social behaviour taking place in reality • Increased ability to study humans in networks and contexts and behaviour as it is affected by sequences of events. Simulation techniques are already being used, e.g. agent-based modelling to study shopping behaviour. The time horizon for the realisation of this application is 21 to 50 years. Impacts are as yet uncertain and there is likely to be some controversy on the topic.	
Title of brief	**Ambient Displays at the Human-Computer Interface**
Main results New display technologies may enable "ubiquitous computing", where the physical location of data and processing power are no longer apparent to the user. Ubiquitous computing requires displays wherever the user might need them: in appliances, tabletops, public transport, walls etc. Types include tabletop workspaces, smart walls, chairtop work surfaces and control pads, "web signs" (digital signs that are flexibly programmable web displays for specific purposes), public display boards, floating augmented reality (personal information artefacts viewable through	

light head-mounted displays, possibly later direct neural connections), paper-thin digital displays, e-paper and textile displays enabled through OLEDs and OLEPs.

Ambient displays are expected to appear in developed countries within 5 years (high-end, speciality applications). Use in consumer applications worldwide is expected in 10-20years.

Implications include:
- Enhanced personal productivity and greater efficiency at work
- Closer integration of team efforts
- More collaborative use of existing work, living and public spaces.

Important drivers are a decrease in OLED manufacturing costs, the introduction of new flat screen form factors and the adoption of new applications by consumers.

Over all, this development is regarded as likely, although its impact will be limited. It is also expected to cause little controversy.

Fraunhofer's research on "roomware" is listed as an early indicator, suggesting a good European position in some areas. The formation of the Ambient Display Research Group at the UC Berkeley, licensing of Universal Display Corp.'s flexible OLED display, and Mitsubishi's prototyping of novel ambient displays as other early indicators hint at competition in the field

Title of brief	**Highways and Vehicles for Increased Capacity and Safety**

Main results
There has already been a successful demonstration of automated driving technology in the San Diego area. The system controls a vehicle's steering, braking and throttling. The deployment of AHS is expected to lead to considerable improvements in safety and productivity in mass transit (buses) and trucking over the next 20 years. "Intelligent personal systems" will find use to carry people to their destination in an intelligent way due to the existence of information on origin and destination.

Expected implications include:
- Improved safety,
- More predictable travel times
- Greater roadway capacity and reduced traffic congestion
- More attractive public transportation
- Conservation of fuel and reduction in emissions.

Driverless buses are already deployed as shuttles in the Netherlands, Honda, Buick and Toyota have already developed prototype vehicles. A sign for a breakthrough would be the introduction of the first luxury automobile model with automated highway driving capabilities.

Drivers and enablers are growing roadway congestion, higher per capita automobile ownership and use, rising fuel prices, the further development of embedded AI in vehicles, growing demand for road safety.

Europe is more likely to fund AHS infrastructures than the US, there might be considerable driver resistance to external control systems and "platooning". There are already electronic road pricing systems in place in Europe to familiarise the public with roadway management systems.

Title of brief	**Broadband Networks Available Anywhere, Anytime**

Main results
A nearly ubiquitous broadband architecture of wireless services for users is expected to be available globally by 2015.

Software defined radio and/or multimode chips and smart antenna technology will allow users to move seamlessly between various types of physical networks (RFID, near field, PAN, WAN, W-LAN, metro broadband).

By 2015 wireless broadband coverage in developed countries is expected to be virtually complete in urban areas and along major transit routes. From 2010 to 2020, linkage of users to the most appropriate networks in terms of price and performance will be achieved through co-existing network architectures with their own networking protocols. Existing networks in 2020 will include those with controlled and managed access points and ad-hoc or mesh networks.

Ad-hoc networks can be installed at low cost and as needed, making them more economic than any other network design. Mesh networks are of two types according to connection arrangements: all to all other nodes, partial connection between those nodes needing to exchange data.

Wireless sensor networks are expected to be a major component of the telecommunications infrastructure by 2020 (networks of sensors embedded in equipment, facilities etc.). RFID tags will connect with each other and data collection environments. The existing fibre-optic backbone will be upgraded to improve throughput by combining and transmitting multiple signals simultaneously at different wavelengths on the same fibre (wave division multiplexing, WDM or dense wave division multiplexing, DWDM).

The main implications are: a potential for mobile wireless users to instantly connect to each other, local geoweb servers with tiny screens, digicams, video graphic messages, music, interaction with pervasive contextual, geospatial or locative media and information.

Mobile phones already on the way to becoming digital terminals for data, text, media and voice over IP at declining costs.

In 2005-2006 there were first trials of Imax services from Intel and others.
A major driver is the increasing demand for broadband wireless services by enterprises and home users.

UK has important pioneer application “The Cloud”, otherwise no specific mention of European developments.

Title of brief	**Computing on the Human Platform**

Main results
It will be possible to mediate interaction between personal electronic products by means of the human skin, resulting in convergence of electronic implants, wearables and personal area networks. While first applications will be of therapeutic nature to compensate for disabilities, there is likely to be a shift towards augmentation of otherwise "healthy" humans, e.g. optoelectronic implants designed to restore lost vision could be used to give people the ability to see outside the visible spectrum. Korea is expected to play a leading role in the adoption of such technologies due to the popularity of plastic surgery and high broadband use.

The expected implications include:
- Therapeutic use to improve impaired hearing and vision
- Use for therapies for paralysis
- Provision of telemedicine for the elderly in smart homes
- Tracking and "body hacking" as downside

A crucial driver is the development of subdermal lithium-ion batteries that can be charged through magnetic induction.

It is expected that there will be some controversy surrounding applications. Significant resistance might take place on social, moral, ethical or religious grounds. It might be possible to achieve the same effects with non-invasive wearables.

Title of brief	**The Dream of Biochemical Computing**

Main Results
Biological computing is alternative approach, which might open up new opportunities. First practical biochemical nanocomputing devices are still more than a decade away, but development is fuelled by massive investment in research in genomics and nanotechnologies. DNA computers could offer highly parallel processing and use very little energy. Computation time is expected to a matter of seconds, but finding the desired answer could take days. Eventually a DNA or nanomolecular computer could be cheap and powerful, potentially capable of combinatorial optimisation, associative searching.
Implications:
- Almost unimaginable improvements in computing speed and power
- Development of an entirely new biocomputer industry
- Vast potential to develop new medicines and life forms, improvements in disease treatments, growth of crops.

An experimental DNA computer capable of 330 trillion operations per second (over 100,000 times the speed of the fastest PC) already built in Israel. Major drivers are the challenges of global human health care and food production, demand for computing power, funding by governments, universities and commercial enterprises. The time horizon for this item is long: over twenty to over fifty years. While it is fairly likely, it will have medium to low impact, although it is expected to be uncontroversial.

DNA computing is superior for certain purposes, but still requires human intervention to separate out correct solutions. It is unlikely to ever provide general purpose computing such as word processing.

Title of brief	**The End of Cyberspace**

Main results

The concept of a distinct "cyberspace" has influenced thinking about IT, e-commerce, copyright and hi-tech products. New technologies actually reveal a more complex relationship between data-space and the real world. The concept suggests a kind of alternate dimension, separate from and sometimes superior to general life and physical reality. The concept implies "immersion", in which users inhabit the same space as their data. Pervasive or ubiquitous computing has created a more complex relation between physical space and cyberspace. New devices will allow users to attend to both the digital and physical spaces simultaneously. Despite predictions concerning "virtual reality", virtual spaces are not an alternative space to inhabit. "Augmented reality", which maps digital media to the physical world, has proved to be more useful than fully immersive virtual reality (direct quote from the fiche). Cyberspace is emerging as a layer atop or beneath the everyday world.

The implications of this development include:

- Disruption of social networks and contexts contributing to the effective use of information by PCs. Development of new devices prevents such disruptions of social interactions.
- Most web services etc. have been developed for desktop computers. With the growing number of mobile users, designers will have to change their practices.
- In the past, discussion on the application of copyright and intellectual property depended on the notion of cyberspace as a space. The disappearance of the metaphor would force legal theorists to rethink their arguments.
- In some parts of the world, mobile devices are already primary devices to access the internet.
- Important enables are pervasive computing technologies, like flexible displays, smart dust, sensors and wireless.

This development is expected to take place within the next 3 to 10 years and to be the subject of little controversy.

Title of brief	**Engineering the Computer-Brain Interface**

Main results

It is expected that the first physical neural interface between a computer and a human brain will be demonstrated between 2015 and 2020. With the advent of such interfaces, humans will be able to interact directly with computers by thinking. First successful implementations are expected at the interface between research on human perception, prosthetic engineering, medical and computer science, signal processing, molecular biology and nanotechnology.

Expected impacts include:

- Potential for the restoration or enhancement of mobility and sensory capabilities through connections to digital sensors and electromechanical and robot systems.
- Potential for direct augmentation of cognition with external computation, extension of physical capabilities with electromechanical and robotic devices.
- Potential for outside control of human behaviour through digital media.

It is likely that breakthroughs will be achieved primarily in applications for the disabled: persons with impaired vision or hearing, amputees (military). This development is viewed to be reasonably likely (high to medium likelihood), its impact expected to be medium to low, while it is expected to create some (medium) controversy.

Title of brief	**Manufacture with Programmable Materials**

Main results

New nano-materials with unique properties and functions could significantly change many segments of the materials manufacturing industries. The technology could also be used to develop structures not previously observed in nature, including bio-inspired materials. Potential applications include:

- Manufacturing of nanostructured metals, ceramics and polymers in exact shapes without machining
- Improving printing through the use of nanometre-scale particles uniting the best properties of dyes and pigments
- Nanofabrication on a chip with high levels of complexity and functionality.
- Among the implications identified are:
- Proliferation of lighter, stronger programmable materials to be used in everything from construction to computing and health care
- Emergence of new manufacturing paradigm based on small-scale molecular assembly
- Reduction in life-cycle costs of materials through lower failure rates
- Emergence of innovative devices based on new principles and architectures
- Possible decline of traditional manufacturing regions, emergence of new manufacturing regions in developed and developing economies.

The first signs of realisation could be a nanofactory in a laboratory capable of building a larger version of itself and the production of self-assembling materials which mimic biological growth processes.

This application could be realised within the next 11 to 20 years and is expected to be moderately controversial.

Title of brief	**New Dominance of Parallel Programming**

Main results

Programming approaches are investigated for different types of computing equipment. Parallel programming is expected to become the dominant type except for small scale mobile and embedded devices. It is necessitated by a range of new computing architectures:

- Virtual computers (multiple cores on a single chip)
- Nanoscale computers (perhaps quantum computers)
- Grid or cluster computing over broadband networks

The software must provide enough concurrent operations to use all the hardware. Massive parallelism requires special programming skills and education and training of programmers seems to be a major challenge.

The implications include:

- A need for research laboratories and software companies to develop new tools for programmers.
- A need for educational institutions to increase instruction for effective uses of parallel processing for application design.

This development is expected within the next 3 to 10 years.

Title of brief	**New Technologies for Cooperation**

Main results
Technologies and practices will be developed to enhance established cooperative working and working in ad-hoc groups, e.g. self-organisation mesh networks, community computing grids, social mobile computing, peer production networks, social software, social accounting methods (rating, ranking, referral mechanisms to build trust), knowledge collectives. The new tools can support the emergence of new markets and spaces for the creation of economic value.

Implications include:
- The shift to more informal ad-hoc collaboration in organisations
- Shortening of innovation and development cycles for new cooperative technologies
- Increased effectiveness of rapid decision-making within organisations
- Increased effectiveness of online economies against off-line due to effective trust mechanisms.

Indicators of this development are the rapid spread of wikis and blogs, the appropriation of art and media through mash-ups and remixing and the formation of clans in MMPOGs.

This development is being enabled and driven by increasing broadband penetration, the development of advanced mobile devices and wireless data networks, and the continuing development of software agents. The events needed for this to happen will take place in the next 3 to 10 years and it is expected to be fairly uncontroversial.

Title of brief	**Quantum Computing Breakthroughs**

Main results
Working prototypes of quantum computers may be expected by 2040. Great progress is taking place worldwide e.g. at the Centre for Quantum Computing (a joint venture of the UK universities of Oxford and Cambridge). Implementation of quantum computing would make certain types of computing extremely fast. QC could enable previously impossible tasks, such as image understanding, real-time speech recognition, generation of unbreakable codes, extreme compression of data and media.

Among the implications are:
- enhanced data security
- Decreased size of data storage devices
- Complex tasks can be performed with speed and accuracy

The time horizon for breakthroughs is still 21 to 50 years. The development is regarded as generally uncontroversial.

Title of brief	**The Rise of Proactive and Context-Aware Computing**

Main results

Computer systems anticipating users' needs are expected to available within the next 10 years. A range of complex automated tasks could be performed proactively if the unit were able to sense a person, application or device's context.

Examples include:

- Searching a smart calendar or itinerary for available times and destinations
- Preconfiguration of logins and identities
- Setting appointments with colleagues
- Distributing documents and meeting work products.

The result is expected to be enhanced personal and group productivity. Not expected to be controversial.

Title of brief	**Supercomputing on demand**

Main results

Supercomputing services will become available over broadband terrestrial and wireless Internet networks by 2015.

Effective supercomputing applications are currently restricted to large industries (petroleum and energy, aircraft and automotive design, pharmaceuticals). Migration to mass applications, such as media, gaming, ubiquitous computing, is expected. This has been recognised by major computer and Internet companies.

On-demand supercomputing includes grid computing, autonomic computing, adaptable computing, cluster computing, agile IT. The goal is to make supercomputing power available from a "grid" – the main building blocks so far are commodity microprocessors linked into Linux clusters. Currently, resources are underused due to bottlenecks in programming (see separate dossier), but by 2015 it is expected that programming obstacles will have been overcome.

Applications include pervasive computing, sensor nets, speech recognition, language translation, image recognition, online games, ubiquitous media. Industrial use will include numerically modelling, high-resolution simulations, real-time interactive graphic models.

The idea of sharing computer power via networks was the original role conceived for the Internet – the idea of linking people came later. Among the implications are:

- Decreased cost and expanded availability of supercomputing
- Enhanced photo-realistic capabilities for interactive entertainment and other high-resolution media
- Potential for enhanced signal-sensing and cryptographic applications
- This development is being driven by an increasing supply of skilled programmers for massively parallel applications, and continued research into simpler massively parallel and threaded programming. It is expected that results will be visible within 3 to 10 years. Controversy is expected to be low.

Title of brief	**Tiny Data Servers, Huge Capacities**

Major results

Tiny processors and web servers, some as small as specks of dust, may be widely embedded in the environment and physical objects by 2015. In 2003 IBM researchers forecast that by 2007 tiny servers with a 10 GB capacity would be available for a dollar each. A demonstration of such a device took place in March 2005.

The main implications are:

- The feasibility of light and small mobile devices
- Ability to connect practically any device or appliance to a network for control.
- This development is expected within the next 3 to 10 years and will be linked with little controversy.

Title of brief	**Tracking Physical Objects Made Easy with RFID**

Main results

Despite potential abuse, RFID tagging systems will be widely used to identify and track physical objects by 2015.

To date RFID has been used most extensively in logistics (airline bagging, food supply monitoring). Use in such applications as passports and identity cards raise concerns related to privacy and confidentiality. EU information privacy law is regarded as likely to complicate RFID implementation and deployment.

Implications include:

- Improved inventory management
- Increased efficiency in logistics systems
- Enhanced security in transportation networks and baggage systems.

Application is being driven by security concerns, efficiency concerns and the development of legal frameworks for privacy protection.

Despite the note above, controversy is expected to be low. Developments are expected in the next 3 to 10 years.

Title of Brief	**Leapfrogging: New Approach to Economic Development + Mobile Phones and Economic Growth in the Developing World**

Main results

Distributed and wireless technologies may be an option for the rapid development of an economic infrastructure in poor, developing countries.

Miniaturisation, wireless communications and embedded computation are components used to leapfrog conventional development along a path similar to that of industrialised countries. The dossier mentions a strategy employed by Grameen telecom in Bagladesh with a modular, rapidly deployable cellular wireless network with shared mobile phones, linked with microcredit lending.

Mobile phones are shared as a resource in owners' social networks and thus increase access by several times the number of phones.

Title of brief	**Off-Shoring of White-Collar Work Drives Globalisation**
Main results The next wave of global trade could be in services and information-processing delivered electronically. To date, this has mainly been in the software development and telephone-based customer service branches, but could in future extend to information analysis tasks. It is possible that jobs lost in developed countries during this development will be replaced by higher-skilled positions.	
Title of brief	**Studying Human Behaviour in Cyberspace**
Main results There will be new methods and theories for the study of online interaction in the new discipline of cyber-ethnography. Cyberethnographers participate in and observe blogs, web sites and chatrooms. In cyberspace the boundaries of the field are both virtual and embedded in place, discursive and geographical.	

Name of Study: ***Outsights- Ipsos MORI (2005-2006):*** Sigma Scan for the UK Foresight Programme: Horizon Scanning Centre, UK Government Office of Science and Innovation	
Promoter/Initiator	UK Foresight Programme: Horizon Scanning Centre, UK Government Office of Science and Innovation
Agency or organisation responsible for activity/research	Ipsos MORI Sigmascan
Time horizon	2005-2055
Objectives of the document	Part of the UK Foresight programme's horizon scanning activities to provide early warning.
Title of brief	**Serious, organised and networked crime: Criminal Networks in the Era of Globalisation**
Main results Organised crime is evolving towards more fluid, decentralised global networks. Technologies such as the internet and encrypted communications are offering new opportunities for criminal ventures. Sophisticated cyber crime is on the rise. New types include "cyber-thefts", attacks against vulnerable spots in the information economy Implications include: - Greater scope for crime across physical and political boundaries with related distance and jurisdictional problems for law enforcement - Reduced consumer confidence - Counter-measures frequently raise privacy and data protection concerns.	
Title of brief	**Live to Work: Pervasive working culture**
Main results A pervasive culture of work may emerge in which economic security and prosperity come at the price of excessive working hours, health and well-being. The speed and ubiquity of IT-enabled communication and the move towards a more "24 hour" consumer society are creating pressure on employees and employers to work longer to maintain competitiveness.	
Title of brief	**Mathematical world: living inside a world of continuous computing**
Main results The growth in computing and processing power embedded in everyday objects and places will permit new levels of pattern recognition and understanding of a wide range of systems. This is combined with vast increases in storage capacity, processing power and interconnectivity enabling speeds making real-time problem-solving feasible. The world will be viewed through a mathematical lens, but through traditional, non-mathematical interfaces. Applications raise concerns of trust in complex systems, possibly also increasing dependence and vulnerability to failures.	

Title of brief	**Come together: Virtual communities, multiple identities?**
Main results New technology is enabling the emergence of new forms of global communities drawn together by common interests. This may lead to the adoption of multiple identities. The phenomenon can unleash huge creative forces and foster social capital, but since it also permits new forms of criminal behaviour, it also challenges legislation.	
Title of brief	**No place like home: The Rise of Home working and e-Commuting**
Main results Technological development and quicker and more powerful communications will enable more home-working and allow the reduction of office space. Impacts could include changed working hours, attitudes to work, environmental impact through reduction of commuter traffic, changes to the structure of cities. Greater use of flexi-time is likely. Distinction between home and work could blur, reduction of cohesion in offices is possible	
Title of brief	**Who's Looking At you? Increasing Mass Surveillance**
Main results The introduction of measures and technologies for increased mass surveillance is being favoured by current public concerns over security and terror threats. Technology includes cameras and CCTV, loyalty cards, information captured through behaviour on the Internet, biometric ID cards. Use and sharing of information is giving rise to data protection and privacy concerns and the actual impact on crime rates is controversial.	
Title of brief	**The Extended self: better than well**
Main results Past technological enhancement measures have tended to focus on the physical environment. Over the next 50 years, technology will also offer opportunities to remake human minds and bodies in fundamental ways through biotechnology, neuroscience, information technology, robotics and their convergence. Use for human enhancement is the subject of heated controversy.	
Title of brief	**Emergence: expect the unexpected from complex systems**
Main results Systems can have different behaviour than the sum of their parts (e.g. crowds, ant colonies). The World Wide Web is another example: it has emerged through the connection of computers using basic rules. Computer power enables researchers to understand patterns of complex behaviour and to use rules discovered in this way deliberately. This may allow the simulation and design of complex emergent systems in areas from the life sciences and economics to trading and marketing. Wikipedia is an outstanding example of an emergent system.	

Title of brief	**Security: marrying technological and human approaches**
Main results Detection, identification and surveillance are the most import technologies underpinning understanding of crime and security in a complex, networked world. Many of the existing threats have been complicated by increased international mobility: hence use of scanners and sensors for detection, biometrics for identification. Potentially: agent-based searching to identify suspicious e-mails. Area of great controversy.	
Title of brief	**Connectivity and Network Interactions**
Main results Growth of networks and embedding of IT in everyday objects are leading to a decreasing distinction between physical and virtual environments. In the future, there might be dependence on an invisible technological infrastructure enabling new forms of communication between people and objects, and between the objects themselves. "Anything" is added to the "anytime, anywhere" phenomenon.	
Title of brief	**Information Management and Handling: controlling the rising flood of data that surrounds us**
Main results The volume of stored data is said to have doubled from 1999 to 2002 and rapid increases are likely to continue. Thus a major priority is to create tools to find, synthesise, manipulate and apply data effectively and efficiently. User interfaces are crucial. 3G technology is already being used to access information (e.g. location-based services); speech recognition has an important role to play in making search more usable, as is less power-hungry display technology.	
Title of brief	**Understanding Complexity: how to answer the big questions**
Main results Complex problems have until recently been approached by science through simplification or by ignoring them altogether. Complex systems have recently become more amenable to scientific study through the ability to handle large data sets due to greater computing power and improved modelling and simulation systems.	
Title of brief	T**echnology to empower the greying generation**
Main results Due to ageing of populations worldwide, there are calls to give attention to the needs of the elderly when designing technology, e.g. to take account of physical abilities or visual capacity. There are three categories of technology for the elderly: - technology accessible for the elderly - technology to improve the quality of life - technologies to hold back ageing. - Increasing demand from elderly consumers will lead to redesign of user interfaces, e.g. introduction of speech recognition and haptic interfaces.	

Title of brief	**The quest for unbreakable code**
Main results	Chinese researchers have shown that the standard SHA-1 algorithm which forms the basis for much computer security is vulnerable to attack. New computers built on novel architectures will enable new mechanisms (e.g. quantum cryptography). Digital watermarking is examined as a method to ensure data security and protect IPR. These raise a number of data protection issues.

Name of Study Tomorrow Project: Glimpses at a Glance What will shape the next 20 years? (1) What might be the implications (2) http://www.tomorrowproject.net/pub/4__Tabs/GLIMPSES_at_a_glance/-378.html	
Promoter/Initiator	Private initiative of two individuals formerly employed by the Confederation of British Industry. The larger majority of the income for the project is derived from supporters, including industry, NGOs and government departments, the normal arrangement with each of whom is a contribution of £10,000 a year, usually agreed for three years. There is also income from speaking engagement and the sale of publications.
Agency or organisation responsible for activity/research	The Tomorrow Project is an independent charity, founded by Michael Moynagh and Richard Worsley in 1996.
Scope/areas covered	The Tomorrow project consists of a programme of research, consultation and communication about people's lives in Britain in the next twenty years.
Time horizon	20 years.
Dimensions addressed in study	The topics of the project are evolving constantly and currently include: - Globalisation - Life course - Individuals, identity and values - Media and technology - Politics and government - Social exclusion - Employment - Sustainability
Objectives of the document	To help individuals and organisations to think and learn about the future of people's lives in order to gain a better understanding of the present and to learn about the choices which will influence the future.
Target groups	Individuals and organisations.

Methodology	Not described, but seems to be based mainly on review of literature
Participation	Probably none, although credits are given for suggestions (e.g. to Ian Pearson)
Major characteristics	Large web-site arranged and indexed by individual topics. Each larger section is also available in a print-ready version.
How have ICTs been included and treated in the study?	ICTs are a key technology shaping the next 20 years. Media are a prime focus of the site.

Main results:

1 - What will shape the next 20 years?

Three sets of influence will shape media over the next twenty years:

1. Technology: cheaper, easier, smarter, and ubiquitous. New applications will be possible.
2. Consumer demand and social needs will influence which technologies take off and how they are used.
3. Economic hurdles as a barrier slowing development.

In **technology,** the report specifically mentions NBIC convergence, although here with the acronym BANG (Bits, atoms, neurons and genes). It points out that caution is needed in predicting media technologies. While some are already on the market (e.g. flat screens), these might be used in ways currently not expected, others are currently about to hit the market, like digital paper. In connection with such technologies, the report points out that experience with most technologies shows that initial take-up is slow. Technologies at stages of very early development or at the concept stage are unpredictable and unlikely to have any impact during the 20 year period. Software technologies are thought to be most unpredictable of all. Uncertain factors in this respect are open source approaches and "genetic programming", in which software writes the first draft software, which is then tweaked and guided by humans.

The report discusses the continued validity of Moore's law and suggests that alternatives to silicon may well be available, e.g. hafnium, which could hugely increase processing power and energy efficiency. Other long-term possibilities include optical computing, DNA computing, carbon nanocomputers, but these are not yet proven.

Since most of today's PCs have features most people hardly use, simplification could make computing cheaper, more reliable and virtually bug-free, e.g. software, storage and processing capacity purchased on demand – computing as a utility. Microsoft is resisting the spread of online software.

Communication costs will fall, e.g. through VoIP; Bluetooth can be used to extend broadband to mobile, symbiotic networks could be created by installing technology to use mobile handsets and other devices as transmitters for short hops (another free access route to broadband).

Easier: Wireless technologies will provide always-on capabilities; convergence will make devices more versatile. The giants of each industry are fighting for pre-eminence in the world of converged devices (e.g. Microsoft, Apple and Nokia).

Media technologies are expected to become more intuitive, enabling e.g. "immersion" into virtual environments. Miniaturisation is making devices even more portable, e.g. through flash memory chips, wearable computers, augmented reality (as a "killer" application for wearables), memory cards for all kinds of data.

Smarter: Evolution and differentiation of software agents, development of the "semantic web" (indexed according to meaning), development of voice recognition, spread of virtual reality, haptics technology, tele-immersion, holograms (including phones).

Pervasiveness: Smart tags will make electronic cash possible, be used to charge for road usage, security (tracking children!), be used in the care of the elderly etc. Other applications include communication between home appliances, collecting information about the environment, supply chain management, vehicle diagnostics etc.

Consumer demand and Needs:
The top ten are:

1. Identity – individual styles etc.
2. Connectedness – e.g. e-mails, SMS, mobile telephony "always on"
3. Entertainment – experience, aesthetics, range of experience (extreme vs. tranquillity), large and small events, participation vs. passivity
4. Self-improvement – adjunct to life-long learning, increasing competition)
5. Health and well-being
6. Security
7. Simplicity
8. Control
9. Personalisation
10. Price

Societal challenges include:
Climate change, maintaining global competitiveness, care for the elderly, the future of democracy.

Economic hurdles are:

- The economic viability of new media technologies and products;
- The possibility that new media products will still favour monopolies;
- High costs of entry;
- Slow User take-up
- The lack of common standards
- Outmoded business models.

2 - What might be the implications?
This section of the website addresses 5 themes:

1. Changes to lives due to media technologies
    - Greater personalisation
    - Central role of interactivity
    - Immersion in "Internet of Things"
    - Virtual reality creates everyday alternatives to the real world

2. Impact on the digital divide
    - The notion of the "digital divide" is elastic
    - As one divide disappears, another will emerge

3. The fragmentation of society due to media technologies

- Media technologies will not lead to individual isolation: many users go on-line to connect with other people, MMPORG and myspace are popular.
- Media technologies need not be a threat to the family: e.g. video messaging and conferencing might strengthen ties.
- Multimedia technologies might nor weaken local communities: neighbourhoods are putting up their own websites and TV broadcasts
- Media technologies need not undermine “society”: while there will be “niche” markets, these will co-exist with blockbusters and mass media events ,which are a source of communications
- Media technologies might widen social divisions: information available via media technologies might find use for people to “sort themselves out”, i.e. move to areas with “my kind of people”.

4. Transformation of people due to use of media technologies
   - There will be huge increases in human capacity: e.g. direct brain-computer interaction (already possible to play video game using wireless headset)
   - Non-linear ways of thinking supported by new media technology
   - There will be a more extrovert culture – always-on music and anytime, anywhere video clips for stimulation, new display technologies, haptic interfaces – introverts might feel more exhausted – extrovert culture will be punctuated with introvert spaces.
   - There will be multiple values, e.g. through the opportunity to experiment with alternative values in VR, there will be a counter-trend to look for greater stability (including search for “ultimate values”).
   - There will be greater “self-reflection”: through opportunity to assume and experiment with different roles (e.g. in VR), people can become more self-conscious about their choice of identity.
   - It is possible that the concept of “human” will change, e.g. through human enhancement with technology (transhumanism).
   - The physical world could become less important, but face-to-face contacts will probably remain important, virtual reality is unlikely to become a full substitute for physical reality. However, there is a tendency for the virtual world to “define” the natural one (e.g. through what one has seen about a specific location in the media). People will expected to be constantly entertained – e.g. when looking at the world, they might wish to know the history of a specific location through “augmented reality” (e.g. donning glasses that show a film on how a location evolved through history)

5. The issue of control.
   - While the media are often blamed by critics for social change perceived as undesirable, the media claim to be driven only by public demand.
   - There is clearly an interplay between the media and the public: The global consolidation of media will continue (trans-national TV companies, local and niche broadcasting will also persist, there might be a tendency to seek greater control over media giants); individuals will be empowered in new ways (greater choice including niche interests, alternative news channels); individuals will be drawn further into the media world they inhabit.

III. Roadmaps and Foresight on Specific Technologies or for Specific Groups

Name of Study: *Nordmann, A. (Rapporteur)*: Converging Technologies – Shaping the Future of European Societies, Brussels: European Commission, DG Research, 2004. EUR 21357	
Promoter/Initiator	European Commission, Directorate-General Research
Agency or organisation responsible for activity/research	High Level Expert Group convened by Foresight Unit in DG Research.
Scope/areas covered	Exploring potential and risks of converging technologies by delineating areas of interest and fields of application of CTS, relating CT to European environment and policy goals
Time horizon	Not specified.
Dimensions addressed in study	"Embedded" devices and applications Unlimited reach challenging boundaries between nature and culture Engineering mind and body Specificity (e.g. targeted products)
Objectives of the document	Improve the understanding of human knowledge and cognition at large. Identification of role of CT within Lisbon Strategy, common goals in European policy framework. Explicit awareness and study of limits needed. Applications in health, education, ICT infrastructure, environment, energy
Target groups	Policy makers at all levels of European Union.
Impact	Widely discussed throughout EU. Caught attention of US (NSF) and Canada (notably Foresight activities)
Methodology	Expert groups with special interest groups below level of plenary group.
Participation	Only experts. Report presented to conference for comment by other experts in the field.
Major characteristics	Expert panel working on predefined topic(s)
How have ICTs been included and treated in the study?	One component technology of converging technologies. The concept of convergence presented here is rather broader than the Nano-Bio-Info-Cogno quartet addressed in the parallel US initiative (Roco/Bainbridge 2002), but also includes these as essential elements
Strengths, weaknesses, opportunities and threats identified in ICT	Alarm about ambitions to turn humans into machines by improving human performance. CT may undermine conventions for warfare (e.g. Geneva Convention). Public acceptance of CT limited by transformative potential. Economic risks (lost investments in R&D). Risk that consumer acceptance will outpace consideration of consequences. Inherited risks of component technologies.

Main results Social sciences and humanities are needed to inform and accompany CT research and to serve as intermediaries. Create settings for mutual learning. Societal feedback to the agenda-setting process via "Begleitforschung" Real time technology assessment should be integrated into CT development (promoted through Begleitforschung) Understanding resistance to new technology Cognitive science, evolutionary anthropology, economics, philosophy Impact of technological environments on cognitive processes "Societal observatory of Converging Technologies" (standing committee) Vision assessment Cognitive science research needed for assessment of best enabling specific NBIC technologies Regulatory framework might require an overhaul Widening Circles of Convergence Initiative (WiCC) as central driving force in EU Strong multi-disciplinarity for CT(EKS) research Proactive education policy Transparent governance process EuroSpecs research process to develop European design specifications for CT.	
Dissemination	Conference, web-site.

Name of Study: *Kenny, Lawrence (2006):* Exploring the Business and Social Impacts of Pervasive Computing. Zürich: IBM	
Promoter/Initiator	IBM Zurich Research Laboratory, Swiss Re Centre for Global Dialogue, TA – SWISS
Agency or organisation responsible for activity/research	IBM Zurich Research Laboratory, Swiss Re Centre for Global Dialogue, TA – SWISS
Scope/areas covered	Central issues and consequences of pervasive computing on the economy and society in general.
Time horizon	Not determined.
Dimensions addressed in study	Description of pervasive computing, essential infrastructure, unpredictability, collaboration and optimisation, underlying social trends, social impact of pervasive computing and privacy.
Objectives of the document	Pervasive computing has the potential to cause a paradigm shift in how societies apply and think of technology. Decision makers need to understand and enable the use of new technology and also to prevent its misuse. Privacy has a central role in the debate on new technologies. The report addresses the question whether pervasive computing requires a change in privacy policy and if it requires a new generation of privacy technologies.
Target groups	Decision makers in industry and politics.
Methodology	Report on a series of workshops involving participants from the organisers' networks.
Participation	Experts invited to workshops.
Major characteristics	Expert workshops as cross-disciplinary dialogue.
How have ICTs been included and treated in the study?	Characteristics of pervasive computing, infrastructures, privacy technology as focus of report
Main results of the study Characteristics of pervasive computing: - Small - Embedded - Networked - Context sensitive - Adaptive - Collaborative - Network volume (sufficient in number and regularity of interaction to create network behaviours) Pervasive computing is not about a single technology, but about a potential qualitative change that may arise through an increasingly integrated technological environment" (p.12). Computing devices will become increasingly like instruments. Pervasive computing will generate a large amount of data, due partly to the massive deployment of sensor devices, but even before this,	

there will be a massive increase. Overall, the sphere of available information is becoming increasingly chaotic. Events lead to the creation of "collateral data".

Pervasive computing needs a seamless infrastructure to help people accomplish their tasks, while making devices and other technology invisible.

The "infrastructure will need to be scalable, reliable and readily available" (p. 20).

"Pervasive computing will use the current network and communications infrastructure, accelerate its convergence and extend it to embrace sensory networks" (p. 20). Pervasive computing adds input on the environment in which users operate and allows different devices to collaborate more autonomously than at present.

Devices are smart and interconnected. There are the following categories of devices:
- Infrastructure (networks, sensors, actuators, RFID tags and readers etc.)
- Access devices (PDAs, laptops, mobile terminals)
- Embedded Intelligence (controllers in cars, washing machines etc.)
- Symbolic keys (tangible things which are convenient representations of services in the real world, e.g. credit cards as representations of payment and credit services.

In pervasive computing, the boundaries between these categories of device will become blurred. The number of devices working "in the background" will grow. The number of mobile components per person will number in hundreds. Devices will include objects not normally considered as communicating devices (toys, household appliances, automobiles, other machines). RFID is expected to be ubiquitous, e.g. replacing barcodes.

There is a clear trend toward communication through several modes at the same time (voice, gestures, point and click control).

There is a need for networks without cables. Up to now there is a difference between WAN and WLAN – pervasive computing needs switching to and fro between the two types (not trivial today).

Infrastructure standards are required to enable network between services, devices etc. Pervasive computing will develop incrementally, starting from applications viewed as robust enough to deserve investment, e.g. in logistics.

A different type of network is required to aggregate data from the "edge of the network" (e.g. sensors). "The aim will be to try and filter and aggregate the data at the "edge" of the network, closer to where the data is collected, leaving the servers to perform more important tasks" (p. 26)

Pervasive computing is characterised by "self organisation" or "system equilibrium" – which stresses interconnectedness and fragile dependencies. (Swirling cluster of nodes). "Critical events" may occur due to complexity and possible move towards irreversible criticality.

Thus there is a need to increase awareness and understanding of limitations and adaptations: electricity grids are an example (comparatively minor events can cause a system crash).

This raises the question of liability: determining the boundaries of ownership, identify system provider, define responsibilities and prove liability.

Complex systems bear the danger of unpredictable behaviour, especially when they exhibit self-organising properties. The question arises, whether to trust complex systems capable of producing "freak events".

Trend towards regular "optimisation".

There will be masses of data, which could be misused, e.g. data to monitor health (danger of transfer of "pay-per-risk model being adopted for health insurance due to availability of data).

Social trends underlying pervasive computing:

- Is there a clearcut distinction between humans and machines in pervasive systems?
- Virtual merger of social, working and family roles – pervasive computing as an extension of "anytime, anywhere" culture
- Mutual adaptation between technology and its users (away from computer input devices) – modelling of user by system (but does this really coincide with what he/she wants?)
- Pervasive computing will have an impact on required skills, some old skills will become redundant with need arising for new ones.
- Availability of pervasive computing interactions could have impact on social interaction (functions replaced by information systems)
- There could in principle be "digital life maps" of individuals
- There might be potential for evasive technologies to disrupt the smooth flow of information and digital traces (geographical reserves where electronic devices are not allowed, technology to aggressively deny unwanted services).
- Dynamic pricing (like prices for airflights, e.g. drink vending machines which adjust prices to the temperature) – possibility of lacking acceptance by consumers since it requires more attention; however, more potential for "pay per risk", e.g. for individual car journey, depending on road and weather conditions.
- Radical extension of potential to monitor the body and to regulate its activities, possibility of funding of medical care according to individual lifestyle choices.
- The paper sets out a strong version of a "pervasive computing" end-game over the issue of privacy.

There is a fault-line between maintaining individual autonomy and the demand for accountability of individuals for their own actions. The balance is sometimes shifted, as by the US Patriot act. Small elements of privacy are sometimes surrendered for incentives, such as discounts. The private sphere is where the individual is not accountable. I.e. if privacy of private sphere is jeopardised by pervasive computing, there is a danger of public rejection. It is also possible that the concept of privacy will change due to technology.

In pervasive computing everything is public until a private sphere is set up by opting out – this could be interpreted as an evasive act. (on the record environment – but this does not imply that all records will be read/used). A question is whether people will object sufficiently to bother to undertake anything against data collection by pervasive systems.

Digital traces are created of many activities and there is a "public interest" in keeping records for crime combating purposes.

The report assumes the maintenance of existing data protection principles:

- Individuals should be in control, give consent and be aware that data is being collected.
- The purpose and use of data must be attached to the data itself and should be verifiable over time
- Appropriate anonymity must be maintained to ensure that a user cannot be identified
- Systems must not link different user actions without prior consent
- There must be agreement and specification on how long data is stored and considered relevant.

Some experts believe that an "on-the-record" environment will challenge this concept – at best it will be possible to create awareness so that choices of service can be made accordingly.

There are three basic positions on responses to the issue of pervasive computing and privacy:
- Limited application of pervasive computing due to the need to respect individual rights and privacy.
- There are potentially technologies to enforce data regulation. The issue is to awaken interest in the development and applications of these technologies.
- Acceptance of the notion that privacy as of today is redundant – a new way of handling privacy must be developed.

The experts in the project suggested improving understanding of what should be the core of privacy and how this will actually be affected by pervasive computing. Applications of pervasive computing with obvious benefits will prepare the ground for technologies to protect existing privacy concepts and principles. A well informed public debate can help to prevent misuse.

Name of Study: ***ITU Internet Reports (2005)***: The Internet of Things. Geneva: ITU	
Promoter/Initiator	International Telecommunication Union, United Nations.
Agency or organisation responsible for activity/research	Strategy and Policy Unit (SPU) of ITU
Scope/areas covered	ICT-Technologies: Internet, RFID, sensor technology, smart technologies, nanotechnology; markets, social concerns
Time horizon	Present to ca. 2015
Dimensions addressed in study	Technical, economic, social
Objectives of the document	Development of a vision "the internet of things" opening up new business perspectives for the telecommunications sector.
Target groups	Industry, policy
Methodology	Desk research, statistics, ad hoc scenario
Participation	Non
Major characteristics	The study is mainly descriptive and technology-oriented. It aims to show new perspectives for the telecommunication industries. Implications for businesses and social concerns are addressed. Overall the emerging "Internet of things" is regarded beneficial even from the perspective of developing countries.
How have ICTs been included and treated in the study?	The study is mainly about ICTs. ICTs, in particular network technologies, RFID, sensor technology, smart technologies, and nanotechnology are at the fore. Opportunities and challenges for businesses, and threats and benefits for society are addressed in the second place.

Main results

The vision of tomorrow's Internet

The study describes a set of new converging technologies, which together enable a further step in ubiquitous, pervasive computing and ambient intelligence. Connectivity, interactivity, context sensitivity of things is the extension to common ICT visions and the focus of the report. The report "takes a look at the next step in 'always on' communications, in which new technologies like radio-frequency identification (RFID) and smart computing promise a world of networked and interconnected devices. By this today's Internet (of data and people) gives way to tomorrow's Internet of Things" (cf. management summary). This is regarded an eminent growth potential for the telecommunications industries with "millions of smart objects communicating with each other" (p. 6).

The enabling technologies become integrated

1. **Next generation networks** will be IP-based, broadband and mobile. There will be horizontally-integrated control layers with simultaneous delivery of applications. The service-related functions will be independent of transport related technologies.
2. **RFID** is seen as the crucial enabling technology: In order to connect everyday

objects and devices to large databases and networks – and indeed to the network of networks (the internet) – a simple, unobtrusive and cost-effective system of item identification is crucial. (RFID) offers this functionality.

3. **Sensors** and "**embedded intelligence**" (smart things) will allow detecting changes in the physical status of things, to process these data and react to them.
4. **Nanotechnology** will provide for a further step in miniaturization of things. Nanotechnology in the ICT-field is said to change ICT-industry dramatically, "particularly the size of data processing modules and storage devices" (p. 38). In addition nanotechnology is used for display technology (nano-structured polymer films), optic cables (nano-crystalline materials), and plays a role in Holographones and HoloTV).

A combination of these developments will create an Internet of Things that connects the world's objects in both a sensory and an intelligent manner. RFID technology, which uses radio waves to identify items, is seen as one of the pivotal enablers of the Internet of Things. Sensors play a pivotal role in bridging the gap between the physical and virtual worlds, and enabling things to respond to changes in their physical environment. Sensors are also important to create awareness about context.

Conditions for a successful innovation process
To realize the potential of the technology many players have to be involved. The Internet of things offers a great potential to consumers, manufacturers and firms. However, for these ground-breaking innovations to grow from idea to specific product or application for the mass market, a difficult process of commercialization is required, involving a wide array of players including standard development organizations, national research centres, service providers, network operators, and lead users.

The standards issue
Managing and fostering rapid innovation is a challenge for governments and industry alike. Standards in nanotechnology and robotics are rather fragmented, with a lack of common definitions and a wide variety of regulating bodies.

Privacy and data protection as mayor challenges
One of the most important challenges in convincing users to adopt emerging technologies is the protection of data and privacy. Concerns over privacy and data protection are widespread, particularly as sensors and smart tags can track users' movements, habits and ongoing preferences.

Consented solutions including users are required
To promote a more widespread adoption of the technologies underlying the Internet of Things, principles of informed consent, data confidentiality and security must be safeguarded. Moreover, protecting privacy must not be limited to technical solutions, but encompass regulatory, market-based and socio-ethical considerations. Unless there are concerted efforts involving all government, civil society and private sector players to protect these values, the development of the Internet of Things will be hampered if not prevented. It is only through awareness of these technological advances, and the challenges they present, that we can seize the future benefits of a fair and user-centric Internet of Things.

Opportunity for developing countries, in particular India and China
Next-generation communication technologies may well originate in the larger growth markets of the developing world – China and India, in particular. The substantial research programmes

currently being undertaken by these developing giants mean that the implementation of the Internet of Things will be adapted to local conditions and circumstances, as well as to international trade.	
Dissemination	To be purchased from ITU http://www.itu.int/osg/spu/

Name of Study: ***Schroll, W.; Rodenhäuser, B.; Neef, A. (2007)***: Mash Up Your Business. Der Web 2.0 Report. Z_Punkt: Essen, Karlsruhe, Berlin	
Promoter/Initiator	Z_Punkt. The Foresight Company
Agency or organisation responsible for activity/research	Z_Punkt
Scope/areas covered	Internet, Web 2.0, digital economy
Time horizon	Present; including an outlook with a non-specified time horizon of ca. 5 to 10 years
Dimensions addressed in study	user, technology, business
Objectives of the document	Information about Web 2.0 developments and their impact on businesses
Target groups	Businesses, broader public
Methodology	Desk research
Participation	None
Major characteristics	The topic Web 2.0 is presented by many examples and illustrated by screenshots and graphs. Consequences of Web 2.0 for businesses are discussed.
How have ICTs been included and treated in the study?	Dealing with Web 2.0, first of all at the application level of ICTs
Strengths, weaknesses, opportunities and threats identified in ICT	*Strengths* of Web 2.0: user involvement, user empowerment, personalisation of services, viral marketing, *Opportunities* for new jobs, new type of software developers, users in the value chain going to earn money from their involvement *Threats* of Web 2.0 for incumbent media industry players, for still centrally controlled data processing units in companies; data protection and privacy issues
Main results Future oriented results 1. Web 2.0 means a further step in the commercialisation of the Internet, as users will be more and more involved in the value chain. Midterm, users or customers will expect remuneration for their contributions and efforts. 2. Social commerce involving customers can take many forms, e.g.: - e-commerce platforms where end-users offer goods themselves, - e-commerce platforms personalising and filtering by means of user input (click streams, social tagging, recommendations etc.) - decentralized e-commerce combining self-expression and users' content with advertising (where end-user gets a share).	

<table>
<tr><td colspan="2">3. Context sensitive ads are considered one of the pivotal innovations in advertising (p.52)

4. The vision "the net is the computer" is reinforced with a notable impact on the work-life in general and online co-operation (joint editing, project management, p2p-environments) in particular.

5. There is an interesting trend that ICT-developments for non professional end-users are driving and challenging IT-departments in businesses. Where incumbent IT-departments are centralised, bureaucratic and inflexible, users may start bypassing them going for web 2.0 services (e.g. enterprise wikis or webtop services).

6. Simple jobs/tasks (information work) can be offered by a company or an agency worldwide and income for unskilled workers can be generated directly (e.g. Amazon Mechanical Turk rendering „return on contribution“.

7. In the long run the ongoing virtualisation (e.g. Second Life) is important for new services, e.g. for the provision of consultation services (e.g. travel agencies)

8. The Web will serve as a new kind of operating system allowing to build on it applications and services based on APIs, new programming tools (e.g. Ajax) aiming to personalise content streams and mashing up content streams from different sources (e.g. city maps and location of members of special interest groups).

9. A well known paradigm of co-operation is open source software development. Web 2.0 in combination with API (application programming interfaces) of Web-Platform providers allows for the creation of new web 2.0 services programmed by a new kind of software developers. Today there are an estimated number of 1.600 Web 2.0 services.

10. A powerful vision is the mobile Internet combined with context sensitive services. Broadband mobile Internet will create opportunities for new context sensitive services and mean a "renaissance of place" (p. 26). This will be a new dimension of ambient intelligence, location based services, and ubiquitous computing (cf. p. 30).

11. Another vision is "desktop manufacturing" or "user manufacturing". In the first case three dimensional objects are produced at the user’s 3d-printer, in the second case users convey their (computer aided) design of objects to manufacturers.</td></tr>
<tr><td>Dissemination</td><td>To be ordered via Z_Punkt website</td></tr>
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Name of Study: *Elon University/Pew Internet Project (2005)*: Imagining the Internet: A History and Forecast.	
Promoter/Initiator	Lee Rainie, director of the Pew Internet & American Life project: invitation to Janna Quitney Anderson of Elon to undertake research initiative. (No government sponsor)
Agency or organisation responsible for activity/research	Elon University, North Carolina. Project led by Janna Quitney Anderson and Connie Ledoux Book.
Scope/areas covered	The project consists of the setting up of a database of predictions on the internet, looking backwards and forwards over 150 years.
Time horizon	150 years in future, 150 years in the past.
Dimensions addressed in study	All dimensions related to internet – collection of predictions, invitation to both experts and lay people to make their own predictions.
Objectives of the document	To replicate the work of de Sola Poole on the telephone (de Sola Poole, I. (1983): Forecasting the Telephone: A Retrospective Technology Assessment) for the Internet. The resource was used as a basis for a Pew Report "The Future of Internet II". The goal is to support "better policy choices and social planning".
Target groups	Experts, lay people. There are also special areas targeted at children (KidZone).
Impact	Not known. The section "voices of the people" consists of 32 pages created since 2004, each consisting of c. 20 items, which indicates considerable public interest in the site. Over all this contains nearly 1000 predictions, as of early March 2007.
Methodology	The report picks out major trends expected for time horizons extending from 2010 to 2150, describing 4 to 5 items for each time period and listing "other possibilities" from a list compiled by Ian Neild and Ian Pearson for a British Telecom Technology timeline. Many of the items are security-related.
Participation	There have been at least three face-to-face events for experts (conferences, forums or workshops). The web site provides anyone with the opportunity to give an opinion or make a prediction.
Major characteristics	The Internet project is part of a comprehensive web-site resource. After the completion of a database of predictions made between 1990 and 1995, an expert survey was conducted about the years ahead. A "voices of the people" section was added in 2004.
How have ICTs been included and treated in the study?	ICTs from the angle of the Internet are the main subject of the study and the site.
Main results By 2010, the NSF is expected to fund a project for the redesign of the Internet called the Global Environment for Networking Investigations (GENI). This will focus on security as its main concern, be able to cope with the increased volume of traffic and also be geared to handling content-delivery for more video and other large-scale projects. According to NSF GENI will "enable the vision of pervasive computing and bridge the gap between the physical and virtual worlds by including mobile, wireless and sensor networks." RFID and GPS will be widespread by 2010 and there will be interactive guidebooks for educational use by tourists. There are	

predictions that computers will surpass the intelligence capacity of humans around 2010.
By 2012, there will be e-ink, e-paper and flexible, foldable computer displays. This will enable the easy and instantaneous changing of price tags in stores, easy-to-change signage on trucks, inside and outside retail outlets and along highways. Stories and photos in newspapers can be updated continuously. It will be possible to include videos in newspapers.
Predictions for the period until 2014 include:

- Artificial Intelligence units will be used as classroom assistants.
- AI soccer teams will provide TV entertainment.
- There will be video tattoos.
- Viewers will be able to pick arbitrary angles or player views to watch sports events.
- Spectator experience at sports grounds will be enhanced with augmented reality.
- Chips with 10 billion transistors.
- Mood-sensitive home décor.
- DNA used to assemble electronic circuits.
- There will be immersive VR shopping booths.
- 60 percent of internet access will be from mobile devices.
- TV quality video screens will be built into clothing, with laws restricting what can be shown on TV clothing.
- There will be a portable translation device for simple conversation.
- Remote control of insects by neural implants.
- On-line surgeries dominate health care.
- Smart pill bottles remotely monitor medication and use alarms.
- Most homes with wireless networks.
- 1 billion Internet users by 2010.
- Electronically mediated tribes as new social structures.
- Frequent use of multiple net identities causes personality disorders.
- Cheap miniature cameras cause social backlash.
- Full voice interaction with computers.
- Personal "black boxes" to record every day life.
- Projected augmented reality.
- Data losses due to format changes cause major business problems.
- Liquid drop lenses for camera phones etc.
- Molecular sized switches.
- Optical neuro computers.
- Simple quantum computer (4 Qubits)
- 100 GB Memory Sticks
- Household access by facial recognition
- Extensive use of electronics to monitor behaviour (crime prevention/detection).
- 60 percent of internet access form mobile devices.
- Single address for emails, phone calls etc.
- HDTV over broadband.

By 2015, it is anticipated that teleportation as known ´from science-fiction, will be developing on the basis of nanotechnology. That year will also see the evolution of smart, adaptable materials. Among the other items forecasted for 2015 are the following:

- 25 percent of all TV celebrities will be synthetic, and the highest paid celebrity will also be synthetic.
- There will be self-aware machine intelligence.
- There will be computer-enhanced dreaming and robot dance tutors.
- Virtual reality scenes will be used as décor in household rooms.

- Academic learning is argued to be unnecessary in the age of smart machines. - Electronic stimulation of brain sensation is a recreational substitute for drugs. By 2020, there are expected to be immersive virtual reality worlds for socialising, entertainment and business. At that time robots will become ubiquitous, taking over many physical jobs and are expected to be granted their own set of rights by 2020. Ian Pearson expects robots to be fully conscious with superhuman levels of intelligence by this time. An open question is whether human intelligence will expand to keep pace through enhancement (downloads, implants) with the robots or be left behind. By 2025, there will be holographic television. The resources go well beyond the time frame of EPIS06 with predictions such as "singularity" taking place some time after 2045 or extensive use of virtual reality in retirement homes.	
Dissemination	Book published on imagining the internet in 2005. Site available and in active use as of end of March 2007.

Name of Study: ***Anderson, J. Q.; Rainie, L. (2006):*** The Future of the Internet II. PEW Internet and American Life Project. Washington DC.	
Promoter/Initiator	The Pew Charitable Trusts.
Agency or organisation responsible for activity/research	Pew Internet & Life Project, Princeton Survey Research Associates International, Elon University School of Communications.
Scope/areas covered	
Time horizon	2020
Dimensions addressed in study	Future of the internet, including devices and technology.
Objectives of the document	Ranking of priorities for the networked future with special section on funding priorities
Target groups	Internet organisations, general public, policy makers (not for specific client)
Impact	Well-visited internet site.
Methodology	The report builds on the online resource "Imagining the Internet: A History and Forecast" (Elon University).
Participation	"Opt in", "self-selecting" survey of Internet experts – initially 200 experts were identified from documents, these were invited to participate and to invite further experts to join in. The first survey in 2003 attracted 304 responses. The 304 persons giving these responses were again invited to participate in the 2005 version, and to invite other experts to respond. In addition, a number of internet and technology organisations were contacted to respond. A total of 742 people responded to the online survey between 30 Nov. 2005 and 4 April 2006.
Major characteristics	This is a large-scale survey on the effect of the internet on social, political and economic life in the year 2020. 742 responses were received from internet leaders, activists, builders and commentators.
How have ICTs been included and treated in the study?	A total of seven scenarios developed on the basis of the previous survey were constructed to "elicit responses to many-layered issues". The scenarios had the following titles: - A global, low-cost network thrives - English displaces other languages - Autonomous technology is a danger - Transparency builds a better world, even at the expense of privacy - Virtual reality is a drain for some - The Internet opens worldwide access to success - Some Luddites/refuseniks will commit terror acts
Main results There is agreement on how technology might evolve, but less agreement on the impact of this evolution. A global low-cost network will be in place and thriving in 2020. There were some	

who said that resistance to change would come from business eager to preserve current advantages. There was also disagreement that the world would “flatten” due to technology.

Most respondents feel that humans will still be in control of technology, but some fear that machines and processes beyond human control could be created. There is less agreement on privacy issues, i.e. whether the benefits of greater transparency will outweigh the loss of privacy.

There will be compelling and addictive virtual worlds which can on the one hand foster productivity and creativity, but lead to addiction problems on the other.

A majority felt that English would remain the most important language for the internet, but others maintained that Mandarin and other languages would expand their influence. The biggest tasks were to build network capacity and to diffuse knowledge about technology.

The scenarios which found agreement among the majority of participants were:
7. (Luddites/refuseniks); 1 (low-cost global network); 5 (virtual reality as a drain for some); 6 (Internet opens worldwide access to success)

The priorities in order of ranked importance (mean rank) were:
- Building the capacity of the network and passing along technological knowledge to those not currently online (1.67)
- Creating a legal and operating environment that allows people to use the internet the way they want, using the software they want (2.05)
- Establishing an easy-to-use, secure international monetary microcredit system (2.90)
- Developing and “arming” an effective international security watchdog organisation (3.25)

Name of Study ***Robinson, N., Ortiz, D., Ligtvoet, A., Botterman, M., Valeri, L., Shoob, R., Nason, E. (2006):*** Security Challenges to the Use and Deployment of Disruptive Technologies. Cambridge: Rand Europe, TR-406-EC, Final Report (D4) 29 September 2006	
Promoter/Initiator	European Commission, DG Information Society and Media, A3 Internet, Information and Network Security.
Agency or organisation responsible for activity/research	Rand Europe, Cambridge, UK.
Scope/areas covered	Five case studies on “disruptive” technologies and their security challenges.
Time horizon	2010 (?), linked with i2010 strategy.
Dimensions addressed in study	Disruptive technologies, security.
Objectives of the document	Development of policy options in the context of the i2010 element of the Lisbon Agenda. Security is a core enabling element for the establishment of a Single European Information Space.
Target groups	Policy makers.
Methodology	Case studies based on literature and interviews, Delphi study, results discussed at expert workshop. Case studies were conducted in specific organisational settings.
Participation	c. 24 experts in Delphi exercise, 10 experts at workshop, 22 expert interviews for case studies.
Major characteristics	Multi-method study
How have ICTs been included and treated in the study?	Five examples of disruptive technologies, with special emphasis on security implications: VoIP (Voice over Internet Protocol) Trusted Computing WiMAX (Wireless Microwave Access) RFID (Radio Frequency Identification) IPv6 (Internet Protocol version 6)
Main results Following Clayton M. Christiansen (Harvard), disruptive technologies are defined as those that sacrifice certain qualities in a product that are attractive to a majority of customers in favour of a different set of characteristics favoured by a minority or also fulfilling a niche need. Disruptive technologies can also create new markets by radically changing the market landscape, e.g. by allowing new players to enter the market. Each of the five examples is treated as a discrete case study. Overall, the research indicated that complex social and economic concerns, such as trust, risk and privacy, are the topmost issues. • The business case for the deployment of the disruptive technologies is not yet fully developed. Security issues are thus still secondary to business concerns.	

- The security challenges present themselves during the transition from one version of a technology to another. If security is not to be undermined, these transitions must be managed properly.
- The perception of the end user is important, since it determines how well the security message can be understood.
- Some of the technologies concerned are key elements of the future European information infrastructure, which makes the security challenges a matter of some urgency.

Policy makers should adopt a supportive and encouraging role to tackle the challenges. Due to the risky nature of disruptive technologies, their adoption is self-regulated, spontaneous and "bottom-up". Too heavy policies at a too early stage could hamper development, but there is a role for targeted intervention is specific enabling areas such as the implementation of IPv6 and legislation addressing privacy, data retention and monitoring.

Governments should play a role where social benefits are expected, even if the market is unwilling to pay. Possible measures include:

- Regulating to reduce misuse and for certification;
- Stimulation of standardisation and certification activities;
- Awareness raising;
- Definition of critical infrastructures and required minimum levels of operation to develop any needed regulatory or financial incentives to ensure protection.

There is a need to recognise all possible players, including those presently without market presence.

The report recommends:

- **Information** of all sectors at all levels about security challenges;
- **Stimulation** of good implementation by development of a coherent European strategy for the implementation of the technologies and a positive regulatory environment for an Ambient intelligence infrastructure;
- **Integration** of security in information systems, e.g. by defining minimum levels or using the buying power of the public sector (demonstrators);
- **Implementation** of risk assessment and protection measures, e.g. improvements to law enforcement measures and the law.

The European Commission could additionally:

- Support large scale demonstrators and the exchange of good practice and standardisation;
- Learn from industry good practice;
- Ensure the avoidance of monocultures
- Provide continued support for pre-competitive R&D
- Improve education and training
- Clarify the legal implications of the new technologies.

Name of Study: *Montagne, R. (Ed.), Causse, A., Elnegaard, N., Ryan, D., Bråten, L. E., Le Floch, L.. Chira, L., Allen, S., Morozova, A., Sánchez, U. (2004)*: Broadband access roadmap based on market assessment and technical-economic analysis. Brussels, December 2004	
Promoter/Initiator	European Commission, DG Information Society Technologies
Agency or organisation responsible for activity/research	BROADWAN project. The 25 BROADWAN partners comprise operators, industry, academia, and consultancy from 10 countries representing all parts of Europe.
Scope/areas covered	Broadband rollout in Europe. The BROADWAN project itself had three main goals: 1. Develop an economically realistic network architecture to provide true broadband services for all citizens in Europe. 2. Bring European industry in the lead for next generation wireless solutions. 3. Motivate advanced utilisation of broadband services at all levels of the society by performing wireless demonstrations and trials in rural areas.
Time horizon	10 years (c. 2014)
Dimensions addressed in study	Conditions of production and deployment for the rollout of systems meeting the market demand at the right time in terms of services and process. The report is one of many deliverables produced by the project.
Objectives of the document	Establishing a ten-year roadmap for broadband access with particular focus on rural and remote areas
Target groups	Not specified, presumably policy makers at national level and in service providers.
Methodology	Prepared by a working group of the overall BROADWAN project, presumably using material from telecoms (project partners) and available literature. No explicit information on working methods. ICT information was collected and processed for three countries representing the variability within Europe: Norway, France and Poland. Estimate of possible coverage for wire line access solutions (DSL, cable and fibre) together with the broadband adoption rate for residential and business segments in a ten-year perspective. This builds on a model of demand forecast, using two curves: "constrained" and "unconstrained" wire line coverage. The WG performed techno-economic analyses focusing on the use of broadband fixed wireless access systems in various types of area: rural with scattered population, small rural town/village, suburban.
Participation	Only expert opinions, possibly workshops.
Major characteristics	Techno-economic analysis to produce roadmap.
How have ICTs been included and treated in the study?	Project was focused entirely on broadband access.
Strengths, weaknesses, opportunities and	In terms of broadband subscriptions, EU territories are closing the gap to North America, but Asia/Pacific region is still ahead in terms of broadband access (Korea as world leader, Japan and US strong,

threats identified in ICT	Scandinavian countries and Benelux in the lead in Europe). China is one of the countries with highest growth rates for broadband access, with 13 Million broadband subscribers. Only China, the US and Japan had more than 10 million broadband subscribers in 2004, although the per capita rates obviously present a completely different picture. There is strong broadband infrastructure competition in the US and Korea. In Europe, competition is strongest in the Netherlands, the UK and Sweden.
Main results WiMAX at 3.5 GHz can be economically viable with existing ADSL subscription levels in rural areas with a household density in excess of 10 per km². In areas with low household densities, grants or subsidies would be required. Wireless extensions could reduce costs through sharing existing infrastructures, such as street lighting, power line posts or cellular base station locations for local repeaters and final access. A survey of broadband tariffs for the consumer market in Europe shows that tariffs in Sweden, Belgium, the Netherlands and France are low compared to Denmark, Spain or the UK. There is a significant span in offerings concerning maximum download speed, depending on the medium used, e.g. fibre. WiMAX cannot compete with ADSL in areas where ADSL does not need changes in the copper infrastructure. As a fixed broadband access technology WiMAX will be mainly restricted to areas without ADSL coverage and areas or countries with poor copper networks. WiMAX can be used for nomadic data applications as an enhanced WLAN technology and eventually as a step towards mobile broadband provision, in developing countries also to provide fixed telephony services. Even in rural towns, WiMAX capacity may be limited depending on the number of subscribers. Mass production is mandatory for any low-cost solution.	
Dissemination	The reports are available from the project web site at: http://www.telenor.no/broadwan/

Name of Study: ***Gonzalez, J.D. (2002)*****:** A Roadmap to Wireless: The State of the Technology. Air2Web	
Promoter/Initiator	Air2Web, provider of mobile marketing and messaging applications
Agency or organisation responsible for activity/research	Air2Web, provider of mobile marketing and messaging applications
Scope/areas covered	Mobile telecommunications with special focus on mobile commerce.
Time horizon	The near future (in 2002): Mobile commerce was anticipated to be "the next business revolution".
Dimensions addressed in study	The questions addressed in the paper are: - What market is to be reached, which technologies are needed? - Objective by offering wireless access; are interactivity and m-commerce important to the business? - Is there a benefit to going wireless without an attached brand? - Extent for need to control features and functions of the application; - Suitability of existing application to wireless use, need for redesign - Internal conditions for the development of wireless applications.
Objectives of the document	Mobile applications cannot simply use solutions developed for the PC, since users have a different set of needs and expectations.
Target groups	Companies wishing to provide services over mobile communications.
Impact	Cited in several scientific papers, otherwise not known.
Methodology	Described as roadmap, but more a list of "dos and don'ts" or best practice.
Participation	None.
Major characteristics	Provides information to help organisations to determine the wireless strategy best suiting their needs. Included are a summary of industry forces shaping wireless technologies, guidelines for development of successful wireless applications, explanations of currently available device technologies and an analysis of deployment alternatives in the market.
How have ICTs been included and treated in the study?	
Strengths, weaknesses, opportunities and threats identified in ICT	The report discusses the pros and cons of various types of mobile device: - Smart phones - Personal Digital Assistants (PDAs) - Web-enabled Phones (WAP) - SMS-enabled phones (virtually all) The paper also addresses alternatives to the internal development of wireless applications, assessing the strengths and weaknesses of the following wireless deployment options:

Aggregators: Purchase generic content from content providers, package it and resell to carriers, who position the content as a value-added service.

For the content provider, aggregators have the following benefits:
- Easy means to distribute content across carriers
- Revenue generating option: aggregator pays outright for content
- Very fast time to market

It also has disadvantages for the content provider:
- Lack of credit, branding opportunities
- Lost opportunity to capitalise on advertising and promotional revenue
- Lost opportunity to connect directly with customers
- Push only – no opportunity to interact with customers
- Limited market access (not all carriers supported by one aggregator)
- Support only for devices compatible with carrier's networks
- Less compelling applications: content typically not customisable by end-user.

Wireless portals: similar to internet portals, content comes from a number of supplies, but is private-labelled by the portal. For content providers, this has the following advantages:
- Opportunity to align with an Internet powerhouse
- Fast means of getting content to the wireless user
- Broader market access – portals typically support multiple carriers

The portal partnership strategy usually has the following disadvantages for content providers:
- Lost opportunity to associate brand with content
- Lost opportunity to connect directly with customers
- Primarily push only; applications typically not interactive
- Content scheduling is limited, placing restrictions on the user
- Users must provide information at enrolment that is difficult to obtain, making the process unpleasant and impacting usage
- No inherent revenue-generating opportunity.

Wireless Application Service Providers (WASPs): Content is accepted in the form of data feeds and coupled with a business logic hosted by the WASP to produce a wireless application. The application typically carries the content provider's brand, providers pay on a usage or transaction basis. Content provider, through branding, can extend consumer reach. They typically lose control over the application's features, since they only provide data-feed. Market reach might be limited through lacking scope of WASPs, lacking device independence etc. When m-commerce is provided, the content provider must ensure that the WASP offers a secure environment – security support varies widely from WASP to WASP.

Wireless Application Platforms: Platforms provide core functionality with interfaces for customer-specific business logic and capabilities for tight integration with existing information systems. Platforms enable businesses to associate offerings with their own brand while shielding

	them from the complexities of having to develop their own solutions. They have the benefit of feature and function control and enable businesses to integrate mobile access including secure m-commerce. They also provide the infrastructure to support interactive multimedia applications independent of carrier, network or device.

Main results

- Mobile applications are best designed specifically for wireless devices. They should extend and not replace existing internet applications.
- Applications should be interactive, not one-way. They should supply users with functionality on-demand.
- Applications should be designed to be user-friendly, provide “easy user experience”.
- Design should bear in mind the intended audience of applications (not necessarily web-savvy).
- Applications should allow personalisation.
- Applications should leverage device characteristics and be aware of device limitations.
- Applications should consider sensitivity to location
- Applications should be “flat”, i.e. eliminate as much hierarchical navigation as possible.
- Applications should be sensitive to security.
- Applications should avoid “screen scraping” (extracting output of data from another program).

At the time of the study, it was expected that the following new technologies would emerge:

- SIM Toolkit – an environment allowing SMS messages to interact with the phone’s operating system, e.g. to facilitate over-the-air application downloads.
- Embedded Java
- Bluetooth
- GPRS
- EDGE as a transition technology from GPRS to 3G
- 3G – to increase data capability

Dissemination	Via website at: http://turtle.ee.ncku.edu.tw/~sun8/homework/MobileIP/present/roadmap.pdf

Name of Study ***Deutsche Bank Research (2006)****:* Media industry facing biggest upheaval since Gutenberg - Media consumers morphing into media makers.	
Promoter/Initiator	
Agency or organisation responsible for activity/research	Deutsche Bank Research, Frankfurt am Main.
Scope/areas covered	Media industry
Time horizon	Present, near future.
Dimensions addressed in study	Media ownership, advertising.
Objectives of the document	Analysis of the economic environment, changes in conventional media, developments in cyberspace.
Target groups	Presumably investors.
Methodology	Desk research, literature research.
Participation	None.
Major characteristics	Literature research focused mainly on media industry.
How have ICTs been included and treated in the study?	Vehicle/driver of change in media industry.
Strengths, weaknesses, opportunities and threats identified in ICT	Report regards direct government intervention in the media as worrying – society would derive greater benefits from a media policy confining itself the regulatory intervention.

Main results

Media websites still constitute a very small segment of the total media industry. TV is the branch of media with the highest turnover. The design of formats in the media industry considers both the advertising market and the media user market.

Advances in ICT and related societal changes are triggering a fundamental upheaval in the media industry, with two important trends:

- Digitisation of content
- Heightened need of "recipients" to make their voices heard.

Technically, the changes are being driven by increasing acceptance of broadband transmission (xDSL, powerline, UMTS, WLAN, Wimax) – 64% of Europeans will use broadband by 2010. Triple Play packages (voice telephony, internet and TV from a single provider) will additionally drive the transformation of the media industry.

Media websites are taking away market shares from newspapers. Newspapers are developing various strategies for use of the web, e.g. complementary websites and features such as

podcasts. Newspapers able to innovate should manage to curb loss of attractiveness with supplementary web-based media. "Radio complements its business without revolutionising it". (p. 6). TV will offer interactive and personalised programming, independent of any scheduling on the part of the TV company. Such a development undermines the financing of conventional TV (no prime time, no advertising blocks). Thus, advertising needs to undergo a fundamental change, e.g. use of split screens, crawl messages (scrolled across the screen) or branded entertainment (advertising integrated into programme introduction). There is the possibility of a lean period for advertising during the transition. Public TV broadcasting is being confronted with the need to adjust to market-based criteria. Piracy is widespread in the digital world (file sharing of music and films) – DRM is possible solution. The Web 2.0 is heralding the "third era" of media history. Web 2.0 implies that "the opinion of masses is gaining significance relative to the well-founded information usually expected of journalism" (p.8). Examples of Web 2.0 phenomena are blogs and on-line libraries (wikis) – often with little regard for copyright (p. 8). According to the report: "Web 2.0 merely documents the realisation that the internet was never just a digital market place but always a social forum for exchanging opinions and knowledge" (p. 8). The dividing line between media consumer and media maker is becoming blurred: conventional media are increasingly relying on information from the web (e.g. derived from journalists' blogs or Flickr); in addition media companies are paying high prices to acquire Web 2.0 sites, mainly for the potential revenue generated by context-sensitive advertising. Major conclusions are: - Interactive and personalised programming are conquering the media; - Alternative forms of advertising are on the advance - There is major involvement of the conventional media in Web 2.0.	
Dissemination	Hardcopy and on-line versions of a series on economics, published several times a month.

Name of Study: ***NCVO Third Sector Foresight (2007)**:* **I**CT Foresight – How online communities can make the net work for VCS. London, February 2007. http://www.ncvo-vol.org.uk/3sf/	
Promoter/Initiator	Vodafone UK Foundation.
Agency or organisation responsible for activity/research	NCVO Third Sector Foresight, a charity which helps voluntary and community organisations (VCOs) to identify and understand the strategic drivers that affect them and provides tools to help organisations transform this understanding into robust strategies helping them to improve their effectiveness.
Scope/areas covered	ICTs and their use by voluntary and community organisations. Evidence suggests that VCOs do not yet take full advantage of ICTs. This report has a particular focus on networks and the shifting relationships in connection with ICTs.
Time horizon	Present and near future.
Dimensions addressed in study	Trends in online communities and social networks, changes in behaviour and modes of communication, identification of strategic opportunities and challenges for VCOs.
Objectives of the document	To help voluntary and community organisations (VCOs) to identify and understand the strategic drivers that affect them and provides tools to help organisations transform this understanding into robust strategies helping them to improve their effectiveness.
Target groups	Voluntary and community organisations (VCOs)
Methodology	Desk research and conversations with a range of experts.
Participation	Experts from VCOs and outside the area (presumably ICT specialists).
Major characteristics	Study of the impact of ICT and related trends on the situation of VCOs.
How have ICTs been included and treated in the study?	ICTs are treated mainly as a tool or vehicle for networking.
Main results The rapid growth of the internet has spawned a new set of online forums and groups (bulletin boards, blogs, wikis, maillists). These can easily be linked and tagged, enabling the identification and organisation of niche communities. This is reinforced by social networking sites like myspace. Innovative VCOs are using not only their own sites, but also social networking software to register their presence on new networks. The communities concerned can be either "bounded" (with registration of members to join forums or to create relevant blogs) or "personalised", meaning that individuals have created their own fluid participative networks of interest. It is no longer sufficient for VCOs to simply push out information from the centre. People now expect organisations to pull in information from other sources. The network generates content. The development as a whole bears six distinct categories of opportunity or risk for VCOs: - Membership: can increase if the VCO establishes itself as a respected aggregator of information, but will decrease if benefits of membership are increasingly freely available	

from elsewhere.

- Information: VCO can assert itself as a source of trusted advice if it draws on a network for information, but will lose credibility if it is unsuccessful in understanding changes in how individuals search for information.
- Transparency: Trust in a VCO is enhanced if its use of technology facilitates a continuous and open dialogue with stakeholders, but is eroded if the VCO is unable to match its culture with the new social tools.
- Collaboration: the involvement of users, volunteers and other supporters makes the VCO innovative and attracts new funding, while inadequate opportunity for collaboration leads to frustration and declining membership in the organisation.
- Fundraising: By connecting donors and recipients through engaging “stories”, the VCO inspires new donors and increases its income, while failure to provide human stories or adequate information about the impact of its work will result in the VCO being passed over by potential donors
- Marketing: By exploiting its networks, the VCO extends its reach and increases its impact, devolving marketing to a VCO’s network could result in “out of control” messages.
- If properly managed, opportunities should outweigh risks. VCOs need to understand the new participative culture to reach out effectively to consumers of cultural changes. New tools require integration into work.

Name of Study: ***OECD Directorate for Science, Technology and Industry, Committee for Information, Computer and Communications Policy, Working Party on the Information Economy (2007):*** Participative Web: User-Created Content. DSTI/IC/IE(2006)7/Final. 12 April 2007	
Promoter/Initiator	Organisation for Economic Co-Operation and development (OECD)
Agency or organisation responsible for activity/research	Working Party on the Information Economy.
Scope/areas covered	The "participative web" which empowers the user to contribute to developing, rating, collaborating on and distributing Internet content and customising Internet applications. User-Created Content UCC
Time horizon	Present, near future.
Dimensions addressed in study	Definition, measurement and drivers of user-created content; Emerging value chains and business models; Economic impacts of user-created content; Social impacts of user-created content; Opportunities and challenges for users, business and policy
Objectives of the document	Among others, exploring the role government could take in this ongoing development.
Target groups	Policy makers, industry?
Methodology	Working group, including elements of literature review.
Participation	Not stated, no information on composition of WP, but report was prepared by two members of OECD Directorate for Science, technology and Industry.
Major characteristics	
How have ICTs been included and treated in the study?	Drivers, tools for User Created Content.
Main results The report proposes the following definition for UCC: *i)* Content made publicly available over the Internet, *ii)* which reflects a "certain amount of creative effort", and *iii)* which is "created outside of professional routines and practices. Available data show that broadband users produce and share content at a high rate, usually younger age groups. Due to network effects, a small number of platforms draw large amounts of traffic (social networking sites, online video sites). Technological drivers include widespread broadband uptake and new web technologies, social drivers include demographic factors and attitudes towards privacy, economic drivers include increased commercial involvement of Internet and media firms in hosting UCC, while legal drivers include the rise of more flexible licensing schemes. There is normally no expectation of remuneration or profit – motivating factors include interconnecting with peers, level of acknowledgement, self-expression.	

The traditional value chain in media publishing is expensive and involves selection, development and distribution. Quality is ensured by “gatekeepers”. Only few works relative to supply escape through these filters.

In UCC, direct creation and distribution of content, many creators and a large supply of content to engage “consumers”, albeit potentially of lower or more diverse quality. Users select through recommending and rating. This could lead to the recognition of creators not selected by traditional media publishers.

Most UCC Sites have in the past been start-ups or non-commercial ventures, but there is now an increasing role of commercial firms in supporting, hosting, aggregating, filtering and diffusing.

There are five basic models for monetising UCC:
- Voluntary contributions
- Pay-per-item or subscription models
- Advertising-based models
- Licensing of content and technology to third parties
- Selling goods and services to the community.

The spread of UCC and the attention given to it by users is a significant disruptive force for traditional content suppliers with related challenges and opportunities. Experimental business models are based on online advertising and marketing.

Users create and watch UCC at the expense of traditional media, reducing advertising revenues; Users become more selective in their media consumption; some UCC platforms host unlicensed material (Pirating). There have already been some changes on the part of traditional media companies: a shift from creating online content to creating facilities and frameworks, greater interactivity of their own website through user comment, rating, content diffusion. TV companies are licensing content to UCC platforms. There is greater competition for professionals from freely provided amateur-created content.

UCC leads to the democratization of media production and the rise (or return) of the amateur. Social impacts include greater user autonomy, increased participation and increased diversity. These may result in lower entry barriers, distribution costs and user costs – digital shelf space is almost limitless.

UCC can provide information and knowledge. Educational content builds on joint production of information, ideas, opinions and knowledge. Discussion fora and product reviews van lead to more informed user and consumer decisions.

Long tail enables diversity, easier to find “niche” audiences. UCC as potential platform for political and societal debates, e.g. via blogs, networking sites.

Challenges include the prevention of divides between computer literate and illiterate citizens, cultural fragmentation as a divisive factor. Accuracy and quality of content are a problem without a system of checks and balances. Other challenges arise in connection with privacy and data safety and possibly adverse effects of (excessive) Internet use.

Policy issues can be grouped under six headings:

- Enhancing R&D, innovation and technology
- Developing a competitive non-discriminatory framework environment
- Enhancing the infrastructure
- Shaping business and regulatory environments
- Governments as producers and users of content
- Better measurement

There is the question whether and how governments should support UCC, in particular in view of its role for competitiveness. UCC also poses challenges for existing regulation, e.g. the separation between regulation of broadcasting and telecommunications. Advertising could also present a new challenge.

IPR and "fair use" are relevant in connection with UCC (e.g. also liability of platforms hosting unauthorised content).

Other issues include:
- Ways of preserving freedom of expression made possible by UCC
- Information and content quality and accuracy problems
- Adult, inappropriate and illegal content, self-regulation or technical solutions
- Safety on the "anonymous" Internet
- Privacy and "identity theft"
- Monitoring the impacts of intensive Internet use
- Network security and spam
- Regulatory questions in dealing with virtual worlds (e.g. taxation, competition)

New statistics and indicators are needed to inform policy.

Name of Study: OECD Foresight Forum "Next Generation Networks": Evolution and Policy Considerations Summary Report. Budapest, 3 October 2006	
Promoter/Initiator	Organisation for Economic Co-operation and Development
Agency or organisation responsible for activity/research	Directorate for Science, Technology and Industry, Committee for Information, Computer and Telecommunications Policy
Scope/areas covered	Overview of technical aspects and structure of Next Generation Networks. Evolution of telecommunication sector due to NGN and converged services. Exploration of technical, regulatory and economic approaches to benefit from NGN. Identification of priority issues for near future.
Time horizon	Immediate future.
Dimensions addressed in study	Technology, regulation, business models, security issues, demand side of NGN.
Objectives of the document	Exploration of key issues and related policy options as subjects of further work and discussion by Working Parties of the OECD's Committee for Information, Computer and Telecommunications Policy.
Target groups	Mainly WGs (see above).
Methodology	Meeting with c. 150 participants. Sessions on technical and regulatory trends, policy approaches, new security issues.
Participation	Expert forum, with 150 experts from major stakeholders.
Major characteristics	Meeting with presentations and discussions. Summary, probably by OECD staff.
How have ICTs been included and treated in the study?	Main focus is on infrastructure, i.e. converged networks.
Main results The term "Next Generation Networks" (NGN) is used in contrast to the existing public internet, with both approaches in competition, although both have common access systems. The main difference is a shift from "circuit switched" networks used for voice to "packet based" networks providing a range of services, including voice, video and data. NGNs can be seen as a logical evolution from separate network infrastructures to a unified network for electronic communications based on internet protocol. Characteristics are security, quality of service and easy access. NGN attempts to simulate constant quality achieved by circuit switched networks, provides detailed service control and security from within the network; Internet only provides basic transmission, is unaware of services supported and service control and security are provided from the edges of the network. From the viewpoint of telecoms operators, NGNs unite the best from the telephony world and the Internet world: give order to the chaos, by keeping the complexity level for users low.	

NGN might stifle openness and innovation.

In NGN, operators are trying to shift up the value chain into audio-visual content. Result is service innovation for consumers with the possibility of new sources of revenue for operators. There were separate regulatory regimes for telephony, data and broadcasting services: Some may become less relevant or obsolete, some may require adaptation.

NGN create new opportunities for competition. Regulation should focus on markets rather than technology, i.e. enabling competition at network and service levels. Service competition may become useful where infrastructure cannot be cost-effectively replicated, or where it is not economically appropriate.

Regulation should adopt a technology neutral approach to ensure competition. Use of “light-touch” regulation and competition law should take place wherever possible. Need to promote interoperability.

Review of the concept of universal service might be necessary if technologies are first applied in profitable and densely populated areas and only expanded at a later stage to commercially less viable areas.

Driver will be demand for video services and data-intensive applications. Socio-economic acceptance likely to have important impact on deployment of networks. Personalisation of applications and services is a key element.

Security problems will be similar to those already existing for the Internet. This is positive to the extent that there is already ongoing work on these issues, but they are still multiplying.

EMERGING TREND UPDATE 1

Introduction to the State-of-the-Art of the Creative Content Sector

EPIS Work Package 1 – Deliverable 1.2 ETU1

Administrative Arrangement
30-CE- 0070769/00-29

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EXECUTIVE SUMMARY

The creative content industries are poised to play a fundamental role in Europe in terms of growth and employment. Those industries are characterised by fast growth rates which outperform overall EU economic growth.

Digital convergence, user-generated content and social networking, as well as changing consumption patterns, are the main phenomena that have been shaping the creative content industry and have contributed to the transformations underway.

Creative content industries cover a variety of activities which means that the various creative content sub-sectors are not affected equally by the above developments:

- ***Music:*** Overall, recorded music sales (physical and digital) continue to decline and although the share of digital sales has been increasing in 2006, this trend does not make up for overall losses in the sector. A successful business model in the music sector is that of iTunes/iPod. The mobile music sector is expected to grow thanks to secure DRM and "walled garden" systems which have been accepted by mobile users and should secure revenue streams.
- ***Broadcasting***: While radio seems to have traditionally served local audiences, we are witnessing an increase in TV stations targeting regional audiences. Thanks to improved storage and distribution capabilities public and commercial broadcasters may reap the benefits of cross-border production and distribution, which should enable them to turn European diversity into a strength. Video-On-Demand "walled garden" business models are expected to grow but competition between technological platforms is striving and lock-in vs open standards is a key question. YouTube and Joost are striking examples of new broadcast models.
- ***Games*** (online and PC) are increasingly important contributors to the growth of the creative content sector and online games are taking an increasing share of the total game market. Mobile games seem to be set for significant growth, the next big development after this being pervasive games.
- ***Publishing:*** book publishing is unlikely to undergo revolutionary changes while the eBook markets have failed to develop so far. However with the emergence of online book discovery services, the whole value chain is about to be challenged. Last but not least, newspaper publishing has been the most affected by ICT developments with declining newspapers sales.
- ***Advertising***: the advertising sector faces the challenge of developing products for an increasing number of channels and platforms. New markets may develop out of the opportunities for personalised and targeted advertising offered by new media platforms.

In spite of some positive and promising trends a number of challenges are faced by the content industries. Those challenges result from the combination of developments like the emergence of Internet as a powerful distribution channel (IP-based standards) that of Peer-to-peer technology, the rise of the amateur and semi-professional creators as well as the explosion in User-Generated-Content (UGC).

The emergence of easy to use creation tools contributes to the lowering of barriers to market entry and makes secondary creation potentially more important (for example through syndication, aggregation, mash-up, searching and organising or filtering as well as data mining).

Overall, such phenomena contribute to unpredictability and uncertainties for actors in the sector. If the creative content sector is to unfold its potential as an engine for jobs and growth in Europe, the following challenges will need to be tackled:

- Improving access to tools and bandwidth (avoiding lock-in situations)
- The characteristic of the creative content industry (large number of SMEs), calls for the establishment of incubators and the fostering of a sharing culture while measures may be needed to facilitate cross-border EU expansion. Access to funding is another problem faced by SMEs while access to research facilities could be a key enabler. Last but not least inter-disciplinary cooperation is needed.
- IPR, DRM and moving from copyright to the right to copy will be essential to unleash the creation potential of Europe.
- Education, training, innovation will have to become cross-disciplinary (ICT skills and creativity have to be mixed)
- European diversity should be used as a strength to promote creative content

Rather than conclusions, the analysis leads to a number of questions which will guide further EPIS research and be used in a Delphi scheduled in June 2007.

STRUCTURE OF THE REPORT

A) Background on EPIS

EPIS is a multi-annual project aimed at improving the strategic intelligence of the European decision-makers by taking a prospective view towards the evolution of ICTs. The first phase of EPIS, EPIS06, focuses on the creative content industries. Main deliverables include:

- The development of an observatory of trends in technology and business evolutions of ICT
- The running of a foresight exercise on the creative content sector
- Exploring specific implications for policies, in particular R&D policy in ICT

B) ETUs and ETU1

Emerging Trade Updates (ETUs) are concise bi-monthly reports focusing each on a selected topic and aimed at identifying emerging new areas and "hot" issues which may lead to significant changes in technical, social or business terms. ETUs should draw the policy makers' attention to the topic studied, posing the appropriate questions so as to help policy decision formulation.

Following a meeting between IPTS and DG INFSO C2, 27 September 2006, it was decided that ETU1 would serve a slightly different purpose, as a matter of exception, and should provide an early picture of the creative content sector. ETU1 therefore presents the state of the art of creative content industries, providing a description of main sub-sectors, highlighting main trends and upcoming challenges. The overview of the sector is complemented with case studies of emerging successful business models.

C) Content

Section 1 includes a definition of what is understood in EPIS as the creative content sector as well as broad characteristics of that sector. It then provides a brief description of the evolution of the following sub-sectors: music, films, broadcasting, games, publishing, advertising, and the public sector.

Section 2 deals with trends starting on those that have had a significant impact as enablers for the creative content sectors, namely convergence, digitisation and broadband/bandwidth. In a second step emerging trends that are affecting the sector are analysed, Internet & the rise of User-Generated Content as well as the changing user culture and consumption behaviours. Last but not least, key technology trends are analysed, from content creation to aggregation and mobility.

Section 3 addresses some of the economic and societal challenges posed by the new media paradigm, with on the one hand changing business models, a specific industry structure and the need to tackle copyright and user rights issues and on the other, the need to reconcile technology and creativity as well as build on European diversity.

In ***Section 4***, we have chosen to analyse some successful business models in the broadcasting, virtual world and IPTV areas as well as the more generic promising case of mobile content. These illustrate some of the profound changes affecting various parts of the creative content sector.

Section 5 raises questions about the future evolution of the sector.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 CREATIVE CONTENT: A DEFINITION

There are numerous definitions of the Creative Content sector, each of which comprises a wide range of heterogeneous activities with diverse levels of industrialisation and commoditisation (ranging from, for example, sculpture to advertising), and radically dissimilar value chains. Because of this diversity, it is not possible to propose a general framework capable of capturing, in a meaningful way, the nuances and idiosyncrasies of this rich variety of activities, and this has made it necessary to select a sub-set of them that appear to be particularly important considering the background of the EPIS06 project.

We define the Creative Content Sector as the collection of activities involving the *"creation and distribution of goods with an intrinsic cultural, aesthetic or entertainment value which appears linked to their novelty and/or uniqueness*". This definition (which, it should be noted, does not specify the direction of the linkage between "novelty" and "value") makes it possible to adopt a tolerant characterisation of our subject matter avoiding traditional differentiations between "high" and "low" cultural activities, or the use of attributes that are restrictive such as "intellectual property" to identify them. It also establishes a clear separation between creative content and media industries (where the value of the content is closely linked to its accuracy and timeliness. The creative content industries have been defined in a number of reports and research works. Although definitions may vary, we found that our definition of the sector is compatible with two particular sources, the KEA Report on the "Economy of Culture" and the Screen Digest Study on "Interactive Content".

The adoption of the aforementioned definition has led to the inclusion of the following sub-sectors of the Creative Content sector in our analysis:

- Music Recording and Publishing
- Film production
- Broadcasting (Radio and TV)
- Games
- Publishing (Newspapers and books)
- Advertising
- Mobile content production
- Cultural spaces (museums and libraries)

In most of the above sub-sectors there is a creative effort aimed at the production of the master copy of a good which is relatively easy to duplicate and distribute digitally (digitise), and as such they follow a publishing or broadcasting model.

In the case of the last sub-sector, we conceive museums and libraries as aggregations of cultural goods that can be digitised and distributed electronically following a model that is, in principle, analogous to the one presented above, although endowed with special characteristics derived from their "public" not-for-profit nature.

1.2 GENERAL CHARACTERISTICS OF THE CREATIVE INDUSTRIES

The heavily industrialised sections of the creative industries are characterised to a large extent by concentration and oligopolisation. This applies to goods production and distribution. Much of the creative work flowing into the goods is being done in so-called micro firms or small and medium-sized enterprises.

According to KEA European Affairs,[155] 5.8 million people were employed in the sector in the EU25 in 2004. The increase in employment was 1.85%, against a decline in overall employment for the 2002 to 2004 period. 46.8% of workers have university degrees, against an average of 25.7% in overall employment. The sector is characterised by a high proportion of self-employed persons, temporary workers and part-time workers. A report on London indicates that fewer women and workers from ethnic minorities are employed in the sector.

1.3 Recorded music

The European music market is the second largest music market worldwide (32.5% of sales) after USA with the UK being the most important market in Europe (and third worldwide).

The **recorded music industry** is probably the industry where changes due to new technology are most visible. Both the music and film industries have been completely shaken by such possibilities as digital copying of CDs and DVDs, peer-to-peer exchange (Napster) and the emergence of downloads (i-tunes) allied to changing consumption patterns. These developments are forcing the industries concerned to rethink their business models and there are signs that this is taking place successfully. There is a period where old and new forms coexist while the old forms will be gradually supplanted by the newer forms, e.g. it is expected that CDs and DVDs will be replaced gradually by downloads or on-demand delivery and consumption. Confronted with illegal file sharing and a fragmented European market in terms of DRM, the music industry is still faced with a degree of uncertainty with respect to future distribution channels and platforms.

Perhaps surprisingly, the largest share of the revenue of the music industry does not come from sales of recorded music, but from commercial radio stations broadcasting music and paid by advertising.

While overall recorded music sales declined by three percent in 2005,[156] digital music sales have doubled in value in 2006 with 50% of them through mobile (90% in Japan). After several years of heavy promotion however, digital sales made up only 10 percent of total music industry revenue in 2006, according to an IFPI report.[157] Some analysts[158] predict that paid-for digital downloads may not live up in the long term.

The US, UK and German digital recorded music markets were dominated by online sales, while Japan and parts of continental Europe (Italy, France) had larger shares of mobile downloads. These are currently mostly master ring tones rather than full track downloads, but the situation seems to be changing. Music seems to be the top entertainment product in 3rd generation (3G) mobile services. As evidenced by a 3G survey carried out by Hutchison in 2006, 60% of the younger generations interviewed (below 24 years old) have downloaded music via their mobile phones and 82% consider their mobile phone as the most important source of entertainment on the move.

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[155] "The economy of culture in Europe", KEA European Affairs (2006), Study prepared for the European Commission (Directorate-General for Education and Culture).
[156] IFPI 2005 - Press Release: www.ifpi.org/content/library/worldsales2005.pdf
[157] 2007 Digital Music Report available at http://www.ifpi.org/content/library/digital-music-report-2007.pdf
[158] Forrester Research for instance

1.4 THE FILM INDUSTRY

Growth in the **movie market** in recent years has been largely due to retail sales of DVDs, which have exceeded box office revenues for some time already. However, most recently, sales of DVDs have declined due partly to piracy and illegal downloads from the net. The movie industry, in response, has turned its attention to exploring new business models, such as Video-on-Demand and digital retail. Analysts Screen Digest expect the total digital movies market to grow from €30m in 2005 to 1.3bn by 2010, driven by digital retail offerings provided over the open internet.

The European film and music industries are generally characterised by weak export potential of their productions unless these are in English. This applies both within the EU member countries (no single market) and to countries beyond Europe. However, the new distribution media provided by the web could provide new opportunities to overcome the unsatisfactory distribution structure for European films, taking advantage also of the Long Tail phenomenon (Anderson 2004).[159] Potentially, ICT multiplies distribution channels and platforms, the distribution of a film or a piece of music no longer depends on the work being distributed through conventional channels by a major company. As long as it is available on the web, a work can be accessed by any consumer. Video-on-Demand also has great potential to increase revenue for European film industries.

1.5 BROADCASTING

Public broadcasting in Europe is a large industry funded through the state budget and/or through licensing fees paid by owners of TV and radio sets. Additional revenues come from the sales of programmes (to other broadcasters), advertising, sales of books and discs. In more recent years, many countries have allowed commercial broadcasting. While TV was originally targeted at the national level, lately there have been increasing numbers of stations catering for restricted local markets. Commercial radio, in contrast, has been mainly serving local audiences, to some extent a return to the situation in the early days of broadcasting when local radio was largely a result of the restricted range of long and medium wave transmitters. However the new media distribution channels enable local content such as radio content to reach beyond local audiences, thus promoting European diversity across regional or national boundaries.

Radio and television broadcasting is an area undergoing radical change due to the opportunities and challenges of digital storage and distribution technologies. The transition from analogue to digital broadcasting, and also to satellite transmission, enables the transmission and reception of a far greater number of individual channels than was possible by analogue means. Additionally, video-on-demand and pay-per-view schemes are expected to capture increasing market shares. There is a trend to separate content into a free segment financed by advertising or licenses and a premium pay-TV segment for recent films, sports etc.

Among the new developments in this area are mobile TV over phone-like devices with suitable screens and online-TV, initially providing content from broadcasters and pay-TV

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[159] The Long Tail phenomenon was coined by Anderson who argued that products that are in low demand or have low sales volume can collectively make up a market share that rivals or exceeds the relatively few current bestsellers and blockbusters, if the store or distribution channel is large enough

operators. On-demand viewing within a "walled-garden"[160] space is expected to spread from Europe's most developed markets to other European countries. The main demand will be for movies and sports.

The distinction between media companies and telecommunications service providers is eroding and will continue to do so. In Europe, the main beneficiaries of the ongoing digital revolution have been telecom operators, e.g. in their role as Internet Service Providers, but competition in this area is very heated with new entrants such as power or cable companies, so that continuing competitiveness depends on the capability of players to provide new attractive content-based services beyond providing fast connections and affordable devices.

1.6 GAMES

A whole new industry entirely dependent on ICT technology has been created in the shape of video gaming. Games are distinct from other creative content sub-sectors in the sense that the game sector was born digital unlike other sub-sectors which have had to evolve or transform their business models because of convergence and digitisation.

In 2003, games global revenues were already two thirds of those of the music industry and worth more than film box-office sales.

The economic dimension of on-line games

The most popular on-line games are played by millions of individuals: the subscriber base for the most popular game, World of Warcraft has reached 8 million players worldwide; there are more than 2 million players in North America, 1.5 million players in Europe, and 3.5 million players in China. The economic significance of on-line gaming can be judged from reports on real-estate dealings in the virtual reality game Second Life. One user, Anshe Chung, pays Linden Lab the equivalent of about $200,000 a year to buy land in Second Life. Ms Chung turns a profit by developing this land into residential communities (such as Hangzhou, Gotland , Emerald Island and so on) and charging avatars rent (The Economist, 2006a). Real-life organisations have a presence in Second life: the well-known Berkeley law professor Lawrence Lessig has held lectures in Second Life, Sweden recently established its own embassy to promote knowledge on Sweden, and there have recently been demonstrations against the Second life headquarters of the French Front National.

The lion's share of the sub-sector revenues came from off-line gaming for consoles and PCs, but an increasing share is coming from on-line gaming which is an area of great interest for Asian countries, e.g. Korea and China, indicating that any European products in this area will come up against competition. On the other hand, Europe's rich culture provides many ideas which could be exploited creatively in games.

The development of the individual, platform-based segments of the computer games market illustrates that:

1. Consoles continue to be an important and hotly contested market as evidenced by the recent launch of Ninendo's Wii and Sony's Play Station 3.
2. Online and wireless games will continue to grow in importance at roughly the same pace, while PC games will lose market shares over time. Since on-line games often require the purchase of PC games, there is some compensation of loss of PC games

[160] "Walled garden" refers to an environment which controls users' access to content and services, as opposed to an open environment. The term is often used in relation to Internet Service Providers or Mobile operators. A "walled garden" makes it difficult or impossible for users to access any content that is not within the "walls".

revenue. A new model may develop with software for games being available for free with limited online game trials, so as to attract audience for online games.

The UK alone is the third largest leisure software market in the world following the US and Japan. Leisure software is an inherently unstable market with periods of famine and feast. Funding is difficult to find. The console industry is dominated by Asian producers like Nintendo and Sony with the only serious competition coming from Microsoft's X-box. Europe is more active in the production of software with the French company Ubisoft being a global player and the United Kingdom the third ranking producer of computer games worldwide after the US and Japan.

Computer games figure quite prominently in local and regional initiatives for the support of the creative industries, e.g. London, the Nordic countries. Montréal in Canada has developed a policy specifically to attract games companies, including the US publisher Electronic Arts and France s Ubisoft, to the city. Among the key conditions for the success of this initiative and for the industry itself are: talented and creative resources, the proper educational infrastructure, a technology community and Government support. (e.g. tax credits and favourable loan conditions).

Findings from a Nordic Innovation Centre report on video games, stress the need to strengthen the cross-disciplinary process opportunities and challenges in emerging markets, the standardisation of the mobile game market, the need for inclusion of women in the games industry and the research community, a need for new business and funding models and for the creation of new networks.

According to the same report, the mobile games industry should be regarded as a new sector, differing from PC and console games. There is a need to support developers utilising the unique features of mobile phones. Pervasive games will be the next growth market after mobile games. Pervasive gaming can best be described as extending the gaming experiences out into the physical world. The PC-gaming experience of today is screen-based; the gaming experience of tomorrow uses your home city street as a playground with everyday life co-existing side by side. The tools used for gaming may be your mobile phone, physical objects with augmented computing functionality or other location-based activities or services.

1.7 PUBLISHING

The publishing industry as the Commission defines it comprises four sectors: newspapers (37% of output), magazines and journals (32%), books (25%), and directories and databases (6%). The EU publishing industry accounts for: 0.5% of GDP, 121 billion Euro of yearly output, 43 billion Euro value-added in the EU-15 alone, 750,000 jobs in 64,000 publishing and 50,000 other companies, most of which are SMEs.

Book publishing

While book publishing remains an important activity, its mutual relationship with ICT is still largely restricted to internal work processes in the industry. European publishers have tended to use the Internet mainly as a marketing environment and not as a distribution channel. European publishers tend to serve national markets, with the exception of the UK, Spain and to a lesser extent France, Germany and the Netherlands, due largely to language concerns. The European book market is dominated by European owned companies. Apart from a sudden take-off of electronic books on mobile multi-purpose platforms for audio, video and print like products, it is unlikely that there will be a radical change in the situation.

eBooks

Despite activities reaching back several years, the market for eBooks in Europe is restricted, both for technological and legal reasons and for lack of demand. Further, the lack of innovation around eBooks can to some extent be attributed to publishers' reluctance to disrupt their existing supply chains. New challenges and opportunities for publishers come from companies like Google, Amazon or the Open Content Alliance (OCA). Google Book Search and similar projects deal with "discoverability" of publications rather than online books or book downloads.

However such projects hold a much more revolutionary potential for publishers as they challenge existing value chains in the publishing business. While the facility of "discoverability" already changes marketing and accessibility of publications, they also go further by allowing users to retrieve specific pages of the respective full text. Google Book Search indexes the full text of books, controls access to the text by only exposing it a few sentences at a time, and facilitates commerce in rights to the text by passing users along to others via links.

Other Printed media

In contrast to book publishing, the publishing of newspapers, magazines and journals is being changed radically by ICT. The circulation of paid daily newspapers has been declining steadily since the beginning of the decade: in 2005 the circulation of paid daily newspapers in Europe had declined to 90.65 million from 96.79 million in 2001. To some extent this has been offset by the emergence and growth of free daily newspapers, usually locally in large cities. This is a European development apparently not paralleled in the US, and all revenue generated by such publications comes from advertising.

Printed media have come under pressure from on-line publications which are linked with lower production and distribution costs. While there continues to be demand for daily printed newspapers, recent years have seen the emergence of daily electronic publications financed by a combination of subscription (e.g. giving access to archives and full versions of a newspaper), and on-line advertising. The latter applies particularly to the local level, where local news resources are being set up on the Internet and challenging local newspapers. At national level, many web portals have news services and Google News for instance provides the option of choosing among various sources for news items, for comparison of various sources on the same news item etc. For publications catering for specialist demand, such as scientific journals and magazines on special interests and hobbies, the Long Tail principle comes into play, so that printed publications have been complemented with or in some cases replaced entirely by on-line versions associated with lower production and mailing costs, giving the reader the advantage of virtually instant delivery compared to paper versions.

1.8 ADVERTISING

Advertising plays an important role in the creative content sector in several respects:

- in terms of content creation, which is being acknowledged through the award of a growing number of prizes for innovative or creative advertising

- in economic terms as an engine for content promotion and distribution and as such a key element of many business models in the creative content sector.

The advertising industry faces a number of challenges and opportunities, having to create products for an increasing numbers of channels and platforms ranging from the traditional ones like radio, TV, the printed media to their equivalent in the digital world with online newspapers, radio, IPTV, as well as online videos and games, mobile content and in general new forms of creative content.

The above channels and platforms are competing for the advertising industry's client base. Many of them, like local radio, commercial television and the Internet, rely on revenue from advertising. Web 2.0 platforms such as You Tube or MySpace, as well as blogs are emerging as new platforms for advertising. In particular small producers catering for the Long Tail" are using these applications for film trailers or to advertise new products. Taking advantage of web 2.0 developments and the means to capture user profiles and tastes, advertisements can be customised to the level of the individual, which opens up new markets and sources of revenues for the advertising sector.

1.9 The Public Sector

Public Sector information is raw material which is also used commercially to create products and provide services. Geographic and meteorological information and data are most notable in this respect, enabling, among other things so-called location-based services. There is also a commitment to enable the access of citizens to national cultural heritage, such as paintings, monuments and books. Content digitisation is obviously a prerequisite for activities in this area and due to the scarcity of public funds, there is likely to be a need for private-public partnerships for the purpose.

ICTs are playing a major role in preserving the cultural heritage in a broad sense. This refers to the digitisation of libraries (books and archives), radio and TV broadcasting archives and music and films, in addition to making museums accessible to people unable to make a journey. An example is Project Gutenberg which seeks to create a repository of literature, in particular works in the public domain and/or out-of-print. A similar project for sound recordings, Project Gramophone, has been hampered in the US by the extension of copyright protection for recorded works and films, illustrating the significance of solutions to IPR issues. Google Book-search is a commercial project in this area.

In the European public sector, there are a number of projects such as the Film online initiative aimed at digitising films and books. DG Information Society is financing an ambitious project for an i2010 digital libraries initiative, which includes a public-private partnership element. The European Digital Library is intended to be a highly visible, multilingual access point seeking to make 2 million books, films, photographs, manuscripts and other cultural works accessible by 2008, with six million projected for 2010.

2. TRENDS IN THE CREATIVE CONTENT INDUSTRIES

2.1 A CHANGING, ENABLING ENVIRONMENT

2.1.1 Convergence

Convergence and its potential impact on the ICT sector has been high on many stakeholders' agenda for some years but digital convergence started to become reality only recently, through the concurrence of developments such as the penetration of broadband, the availability and affordability of high-speed bandwidth, the emergence of multi-purpose devices with increased storage capacities, and last but not least the availability of digital content. The role of the Internet as IP infrastructure and new distribution channel for information has been instrumental in enabling these developments.

Ultimately digital convergence enables individuals to connect to anyone or anything, anytime, anywhere thanks to the ubiquitous availability of access, via fixed, wireless, or mobile technologies and by using any device: "Digital convergence is turning ubiquitous TV sets, PC screens, mobile handsets and consumer electronic devices into end user terminals for interactive media applications and download services" (Screen Digest 2006). Today convergence opens up the way for an array of new applications and services. However multi-language applications are a pre-requisite for wider take-up of services in Europe and beyond, and progress with machine translation will be crucial if Europe is to build upon its cultural diversity and strengthen its position on the creative content sector.

2.1.2 Digitisation

Digitisation, the conversion into digital format of analogue information or content, enables the reproduction and transmission of content at low cost. Once a master copy is created (which may involve significant investment) digital copies can be produced at next to no extra cost. Digitisation represents therefore a key driver for creative content production and distribution as content, once produced and/or digitised, can be distributed over any networks and be accessed through a variety of devices from Digital TV, to mobile phones, to personal computers or palmtops. Digitisation also calls for the implementation of process and tools that facilitate the production of cross-platform content, leading to potential economies of scales as mass markets can be addressed. Further, digitisation opens the way to new markets the so called "middle" and "long" tail",[161] as the incremental cost of adding a consumer in the digital world is close to zero as opposed to what it costs in the "analogue" world. On the other hand digitisation has also brought along one of the major risks for the sustainability of the content sector. As content becomes easy to copy and exchange digitisation inevitably leads to IPR infringement issues that have led the content industries to search for solutions such as DRM. Solutions implemented in the game or music sectors for instance have led to mixed results, sometimes creating barriers to entry in those markets thus impeding the development of a level-playing field or locking users into a system which may also be in breach of competition rules.

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[161] "Middle tail" refers to the part of a market between mass-market and the so-called "Long Tail", the latter representing the millions of niche products which collectively can produce significant market shares *(also see footnote 5)*.

2.1.3 Broadband and bandwidth

Broadband take-up is one of the key pre-requisites for the competitiveness of the digital economy and it has been the focus of EU actions in support of the i2010 goals. As a result, Europe has witnessed increased broadband adoption and growing penetration rates over the last couple of years, with some EU countries already outperforming the US and Japan (Screen Digest 2006). According to Screen Digest estimations, by 2010 Europe will close the gap with the US in terms of broadband penetration rates. The increased competition on broadband markets has doubly benefited consumers who can choose from a varied offer, characterised by lowering prices and higher speeds. The current trend in Europe is towards triple or even quadruple play, i.e. the delivery by one provider of fixed, mobile communications, internet access and TV which leads to a three way battle between telecom, cable and mobile players (European Information Technology Observatory 2006). Whether this trend will continue and yield the expected growth depends on the capabilities of players to "step out of their comfort zone" and adapt to new business areas (Deloitte TMT Trends 2007). In terms of evolution of the creative content sector, broadband and bandwidth are crucial for growth and competitiveness of the sector, as "digital distribution of content can only develop on a large scale when there is a sufficient penetration of devices – allowing consumers to record, playback or store digital content-, as well as a mass-market access to broadband technologies and networks." (Screen Digest).

2.2 SOCIAL TRENDS - THE USER AT THE CENTRE

In this converged environment, the role of internet has been instrumental in enabling new forms of expression. On the one hand, users become more and more master of the information that was once the privilege of large media companies. On the other hand, users have understood how to take advantage of new media tools to satisfy their need to communicate and network. The social trends underlying this phenomenon of user empowerment and networking culture are best evidenced through social computing applications where the user can create and distribute content or decide on what content to consume and how.

2.2.1 Internet and the rise of user-generated content

The Internet is more than a new distribution channel and more than a standardized technical infrastructure for all kinds of media. The Internet allows for a creative sector of a new type, and incumbent creative industries are struggling to adapt and jump on the bandwagon. In doing so, they are competing with net-native companies. The Internet is the basis for an explosion of creativity in terms of user-generated content. This phenomenon has also been termed "the rise of the amateur" (Howe 2007). The emergence of user-generated content depends on new technologies that are accessible and affordable to the general public and allow for easy content production. The Internet platform itself turns out to be the basis for a wealth of new media technologies. The Internet is also the basis for a wealth of secondary media produced by services exploiting and tailoring the available content in many forms. Sharing of content via P2P networks, syndication, aggregation and mash-up of content as well as searching and organising content, filtering, data-mining etc. constitute ICT-based new media content.

The Internet holds great opportunities for mixed media where amateur content and professional content and expertise are brought together (e.g. "citizen journalism"). Eventually there will be no clear dividing line between amateurs and professionals, amateurs may become professionals as has happened with open source programmers. The Internet may turn into a vast talent pool for content creation. Although it may be argued that user creation often consists in "ripping, mixing and burning" in other words copying and pasting professional, legal or illegal content, a new class of content producers is emerging, the semi-professionals whose production value is approaching that of professional content. This trend of unbundling and repacking reveals what users are interested in.

2.2.2 A changing culture: sharing and new consumption behaviours

The advent of the internet and the increasing role of interactivity, enabled by new content, tools and applications, have transformed the traditional passive consumer of media into an active content user-producer, often referred to as "prosumer". The success of social networking websites, blogs, wikis and other web 2.0 types of platforms and applications reveals new patterns of user behaviour. Increasingly users want to share content, products, knowledge, experiences or even emotions. This phenomenon has been facilitated by the emergence of new technologies like P2P which also contributed to the emergence of the "free culture" whereby users are more and more reluctant to pay for content. Users also express their opinions through blogs in particular and do not accept the one-to-many relation that used to prevail with traditional media. In sharing users contribute to the development of communities of interest. Some market players have acknowledged those social trends and start developing new products or new business models by using e.g. psychologists and sociologists to decrypt social trends in order to better adapt their offer to user demands and new consumption behaviours. Furthermore users want to select and decide upon what they want to see or listen to, when, where and through what device. This changing culture altogether has a profound impact on traditional business models and needs to be taken into account by market players.

2.3. TECHNOLOGY TRENDS – CREATING, AGGREGATING AND GOING MOBILE

Creative content industries have undergone important changes which are rooted in the confluence of the above phenomena but the emergence of new tools and technologies will continue to be key in driving the growth of the sector.

2.3.1 Cheaper, better technologies and tools

Improvements in compression technologies, storage capabilities, processing speed are only examples of concurrent technological developments that have contributed to the paradigm for digital communications which is unfolding today. These developments have led to the success of MP3 music, the increased offer of video-on-demand, the provision of IPTV, the advent of online-games to name a few. The availability of new tools, that are easy to use, make content production, publication, promotion and sales accessible to creators, artists and users themselves, removing some of the technical barriers that used to characterise the content sector. However some other barriers have emerged as evidenced by some “lock-in” systems built by video games market players which make it hardly possible for smaller companies to enter the market, as huge investments are needed upfront to acquire licences giving access to source codes.

2.3.2 Aggregators or how to master the wealth of digital information

The more the overall content available on the Internet is growing, the more do techniques matter which help to select, structure, and analyse the amount of information in order to produce tailor-made information products and services. Content aggregators will therefore continue to play an important role not only in relation to text search but increasingly to filter and sort all types of creative content. Audiovisual search engines or audiovisual content aggregators for instance are needed to make sense of the wealth of audiovisual content growing on the internet. New tools may emerge to enable access to the vast hidden parts of the internet that currently escape the filtering of existing search engines.

Google as a media company without proprietary content is the most striking example of a successful aggregator of digital content. Google's success story started with the indexation of web pages and the provision of text search tools. Besides text, Google search also gives access to indexed pictures (based on text titles, meta-tags or hyperlinks), acts as a news aggregator with Google news, and provides location services with Google maps. Blogs and video sharing platforms (via YouTube) are some of the latest products added to the Google portfolio. The key to Google's success besides the algorithm underlying its search engine is the use of advertising based on sponsored links and cost per click. Google controls "nearly 70 percent of the search-related advertising market" today, a market expanding at double digit rates (Oppenheimer, 2007). There are concerns that aggregators such as Google may control too large a share of the digital content and act as “gatekeepers”. Similar concerns apply in the mobile area whereby mobile operators have control over pricing, standards and revenue shares (Screen Digest 2006).

2.3.3 Mobile platforms

Mobile technologies are another key driver of growth in the ICT area, and particularly in the content sector. With high-penetration rates and coverage levels approaching 100%, with the advent of enhanced technologies (e.g. 2.5/ 3G based on UMTS or other standards) and the improved capabilities of handheld devices, content providers are increasingly able to provide existing as well as new content to a large nomadic customer base. Mobile networks are already today capable of transmitting large amount of data, such as for download of video or music, even though the market has not taken-up yet in Europe (Screen Digest). Taking mobility one step further, if or when the new Internet Protocol IPv6 delivers its promises and mobile devices can be IP enabled, mobile internet will become reality and significant growth in mobile content applications and services may be expected. On the other hand, IPv6 implementation for mobile communications will raise privacy issues that will have to be tackled, as it will become possible to locate mobile users at all times through their IP addresses.

The take-up of mobile content use may however be hampered by prohibitive data roaming prices, as has been the case for voice until recently. Europe should not repeat the mistakes of the past when it took many years to enforce harmonisation of roaming rules and pricing but should legislate to achieve data roaming harmonisation and pricing in favour of more user generated traffic. Other potential impediments to mobile content development are the lack of appropriate interface to handle data, the increased battery power and flash memory which mobile phones will need to run data applications.

3. CHALLENGES AND OPPORTUNITIES FOR THE CREATIVE CONTENT SECTOR

3.1 ECONOMIC CHALLENGES

3.1.1 Changing business models

Digital convergence and the changing user culture present both challenges and opportunities for the creative content sector and no part of the sector remains unaffected. From books or publishing to TV, music, movies or games, the combined effect of convergence and digitisation has started to modify the creative content sector's structure and forced traditional business models to adapt to the digital converged environment. Business models are not affected in the same way in each of the sub-sectors as shown in section 1. However it seems that one key element of successful business models in the new media environment is advertising.

The current evolution of business models points into three directions in terms of revenue-generation:

- Subscription based models, whereby users pay a fee in order to access content.
- Advertising-based models, which may be based on revenue-sharing, pay per click etc.
- Product subsidising content, like in the iTunes model where content supports the sales of devices.

Taking advantage of web 2.0 developments and the means to capture user profiles and tastes, advertisements can be customised to the level of the individual, which opens up new markets and sources of revenues for the advertising sector. At the same time, new models emerge enabling users to skip advertisements by paying a fee. The winners in this new media paradigm will be those capable of developing business models based on the right mix between, free and paid content, between advertising and subscription. On the other hand, advertisers face the challenge of winning the attention of consumers who are exposed to an increasing wealth of information. While attention economics becomes more and more prominent in trying to solve this problem the existing legal framework for copyright protection does not facilitate the uptake of such new business models.

3.1.2 Industry structure

A specific characteristic of the creative industries is the small average size of companies active in the field. This includes the heavily industrialised services where such small firms are working on a contractor basis for large companies (like in film production) or on a freelance basis with the hope of eventually selling the product to a large distributor or broadcasting company (e.g. documentary films). Typical problems include lack of access of these companies to the required marketing skills and distribution channels. In some cases, even enabling access to broadband would be beneficial, in addition to support in use of the Internet as a platform for advertising. Going one step further, support measures could be aimed at pooling ICT resources and skills to help small players without the means and skills to develop the necessary infrastructures to implement e.g. online sales. Additionally, the creative industries, in particular the small and medium-sized companies, often have difficulties to access funding. They would benefit from e.g. research and funding schemes that would be less burdensome and time-consuming as they lack the resources to go through such procedures.

Some cities and regions in Europe have established measures to strengthen the ties between the creative industries and the academic sector or are particularly highlighting the availability of higher education institutions serving the creative industries (e.g. London, Berlin, the Nordic Countries). Some of the measures particularly focus on providing those active in the creative industries with the necessary ICT skills, while others address the need for interdisciplinary cooperation between ICT specialists and other creative workers.

The difficulty of access to funding is often furthered by problems in growing from small scale activities to developing larger scale businesses. Regional funds and structural funds may be helpful to foster creative content SMEs.

3.1.3 IPR, DRM, copyright and user rights

One of the main challenges faced by the content industries, and a direct consequence of digital convergence is the issue of Intellectual Property Rights and Digital Rights Management. The ease of copying digital content and distributing it through global networks without significant costs has contributed to the explosion in piracy and infringements of IPRs. Piracy is a threat to a number of content sub-sectors including film and music and to a lesser extent TV, games, publishing and radio. DRM has been implemented in some parts of the sector with mixed results. As restrictive DRM technologies have often failed to facilitate viable business models for digital content in the B2C segment, there is a search for unobtrusive, convenient, reasonably priced services with modest and acceptable restrictions imposed by DRM system. What can be observed in digital content markets is a shift from DRM-technology as "containment" of content to "forensic DRM", i.e. methods to mark, track, and trace the content and/or the owner of the content. Viable DRM strategies will be key to the evolution of the content sector.

In the mobile sector, as opposed to other areas, digital rights management have been implemented from the start. Ring tones are a good example of protected content, which in spite of the limitation imposed on its use (once downloaded to one mobile, ringtones cannot be transferred to any other device) have contributed greatly to mobile revenues. Those rights are difficult to break and have been accepted by users. According to estimates from a 2006 study by GSM Europe on mobile content, the legitimate mobile content market will generate 2.3 bio Euro a year by 2010. The study points out that mobile content will benefit from the implementation of flexible and interoperable DRM system.

There is a need to balance creators rights and user rights. Content creation is being hampered by copyright laws stemming from the analogue world. In a world where user generated content may deliver huge potentials, it is necessary to rethink copyrights so as to give users the right to copy.

3.2 SOCIETAL CHALLENGES

3.2.1 How to reconcile technology and creativity

Bridges need to be established between technology, creativity and management if creative content industries are to develop and compete with other regions. This applies at the level of education, training and lifelong learning, research and innovation, companies' management.

Education in Europe still does not take account of the need to master creating skills together with technology skills. Engineering, business and arts are clearly separate curricula and it is seldom possible to mix these disciplines. Furthermore cross-disciplinary curricula when they exist are often less valued in the academic world than focused paths. However it is necessary to understand the creative process to turn an idea into an application, and vice versa. On the same grounds cross disciplinary research is needed, beyond technology research. Europe would do better if a right mix is reached between creativity and technology expertise. Humanising technology (e.g. story telling, animation, games) is a prerequisite for the development of the creative content industries.

3.2.2 Making European diversity a strength

European cultural diversity is often considered as a barrier to the export and growth of content. However the new media paradigm offers new opportunities to turn diversity into a strength. The growing adoption of various platforms for content display and interaction and the increasing use of online access has enhanced the availability of highly localised content and services, thus contributing to diversity. The “space-agnostic” nature of communication networks, where virtual locations can be accessed on similar terms regardless of physical distance has created new opportunities for creative content creators now able to address their messages, simultaneously, at local and global audiences. This development is particularly important in the context of the creative content sector, which produces goods in many cases characterised by a high a priori cultural specificity.

The phenomenal expansion in the range of audiences that can be accessed does not dissolve space, but multiplies it by turning each of the terminals through which a piece of content is accessed into an extension of its place of origin, in a process which does not lead to cultural homogenisation, but to hybridisation and learning. The case of online museums, manifestations of physical space and virtual entities at the same time is another instance of the importance of localisation in spite of the pervasiveness of global ICT networks.

The enhancement of the population’s creative and content access potential will not, in the absence of suitable business models and institutional frameworks, result in improvements in economic growth, employment or competitiveness: it is necessary to establish a clear-cut distinction between the population’s creativity (an important good in itself), and its materialisation in a successful, economically viable creative content sector, without forgetting the essential linkages between both.

4. CASE STUDIES

4.1. SOCIAL RADIO (PANDORA, LAST.FM)

Pandora, a US-based music streaming service (so-called "music discovery" system), **and Last FM,** a European internet customised radio station and music community site, are two examples of successful business models in the radio broadcasting sector, as evidenced in particular by a fast growing audience, a wide catalogue of references and the growing interest of big music publishers in teaming up with such social radio networks.

4.1.1 Business model analysis

Revenue generation

Pandora uses a mix of free subscription supported by ads and fee-based subscription without ads, referral revenues (links to Amazon and iTunes so users can buy the music they hear) and has also experimented a NPR (National Public Radio)-style ad-based stream allowing users to listen to free music as long as they agree to listen to advertising.

Last FM's revenue streams come from subscriptions (no ads). Originally tracks were offered as a free download service but since Oct 2006, downloads are only possible for tracks on 'indie' labels or for uploads by bands themselves. As part of a recent agreement with Warner, LastFM will provide advertising-supported radio streaming service and a premium subscription-based interactive radio.[162]

Content creation

In both cases the User is a creator: of radio stations, of recommendation / taste (songs are played based on the tastes of other listeners who also like that artist), feedback (user feedback used for future selections). LastFM also builds on connections ('friends' system; shaping user groups between users with similar tastes) and tagging (user-end tagging of artists, albums, and tracks). Users are getting deeply involved in the process of production and service innovation[163] as suppliers of content and through contribution to the design and production of the service. Social radio blurs the distinction between (users) amateur listeners and professional broadcasters.

Content distribution

Through the Pandora music recommendation system, artists can be discovered more easily and they are less reliant on the record companies. Their critical mass drives up e-music sales further (listeners can buy the music they hear by going to Amazon and iTunes). Last FM also makes users' listening habits accessible via an RSS feed.

More generally services can be based either on personalized recommendation (based on the individual's past behaviour) or social recommendation (based on the past behaviour of similar users) e.g Amazon, Last FM, Pandora. The explosion of information has given rise to the 'attention economy'[164] and retailers have a big incentive to provide recommendations to those

[162] Source: Warner Corp. Feb 2007

[163] In 1976, Von Hippel published its seminal work on innovation.

[164] Herbert Simon was perhaps the first to articulate the concept of attention economics when he wrote "...in an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it

users who are "just browsing", to drive them towards a transaction. However, issues like standards and infrastructure for building attention services need to be addressed.

Radio broadcasters are struggling to adapt to the shift in users' behaviours. BBC plans to allow audiences to create personal radio stations from its content (e.g. by combining existing services such as podcasts and the BBC Radio Player) as part of the BBC's iPlayer, a new interface device that shall transport custom content (music, video, reports) to each user. Provisionally called MyBBCRadio, the service would use peer-to-peer technology to provide "thousands, ultimately millions, of individual radio services created by audiences themselves".[165] The new service will also track what listeners like to suggest similar music tracks and other content.

User interaction

Some additional features of Pandora aim at increasing interaction among members (listener profiles with musical preferences, listener search and lists of users who are fans of particular bands). User' feedback influences the selection mechanism by which new tracks are added to the radio station. Last FM is socially driven, while Pandora is driven by trained music analysts, who classify music before it can be listened to on the radio. It is a music community site, where users can form "communities of interest" sharing similar music tastes as well as join discussion forums and a wiki space.

As shown in the above, there is a general shift from the passive role of the user, inherent to the television culture, to an active one, essential to the web culture (from consumption to participation). The user plays a central role in finding/ selecting/filtering content. Tagging and taste-sharing help sharing information and content. Content becomes easily accessible through social context, individuals build new social ties and new social networks (e.g. communities of interest).

4.1.2 Perspectives

Pandora and Last FM are anxiously trying to find and adopt a sustainable business model. Whatever the model chosen (subscription or advertisement), such services will have to make a trade off between generating revenue and getting the user back into re-using the service. However, the implications of the subscription-based online radio are still unclear. Screen Digest believes[166] that it is not likely to gain much support when compared to the free alternative. IFPI reports as well a slowing global growth of online music subscribers which would support this assumption (3.5m online music subscribers globally at the end of 2006, a net addition of 700,000 in the year, compared to 1.2m net additions in 2005). Some free ad-supported content distribution models have emerged (see Annex 1 for further trends across several industries).

is that information consumes. What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it" (Simon 1971).

[165] Source: BBC

[166] Screen Digest Broadband Intelligence, Feb 2007.

4.2 Second Life

Second Life is a virtual world created by Linden Lab which started in 2003 and has reached its **five millionth** inhabitant (March 2007). 54% of active users in January 07 were European vs. 34.5 % Americans, whereby it is estimated that only 10% of created accounts are those of active users.

4.2.1 Business model analysis

Revenues generation

Second Life membership is available for free for users creating a “basic account”. However in order to own land in the virtual environment users have to create a “premium account” and pay a monthly fee. Second Life also offers its members the opportunity to spend real-world dollars on both virtual and real goods and services. A parallel economy has thus developed in Second Life, although revenues generated do not all benefit SL’s creators (Linden Lab) but members themselves.

Content creation

Second Life is a 3-D virtual world entirely built and owned by its residents who can use available modeling tools to enhance their avatar, build virtual buildings, landscape, vehicles, furniture etc. External created graphics, animation, and sounds can be imported into Second Life and a Second Life scripting language can be used to add autonomous behavior to objects.

Second Life is also a virtual incubator for innovation and entrepreneurship. Residents create new goods and services, and buy and sell them in the Second Life virtual world. Second Life statistics claim that 144,108 customers spent money in-world in December 2006. In terms of copyright protection, Second Life residents have copyright over their creations. An item can be marked as "no copy", "no mod" i.e. no modifications can be brought by others or "no trans" i.e. the current owner of the item may not give it to another person.

Content distribution

Second Life gives its members the possibility to create, acquire or sell virtual as well as real goods and services. Further virtual reality worlds may represent a test bed for experimenting and prototyping new ways to communicate to the market and distribute content online. Virtual worlds could transform the way 'real world' businesses operate e.g. from training and collaboration to product design and marketing. Companies from the media, clothing, automotive, ICT, services and many other sectors have opened virtual presence in Second Life as a means to enhance their real-world strategies or extend their product offer.

User interaction

Within Second Life, there are two main methods of text-based communication: local chat, and global "instant messaging". Voice capabilities may be added soon, as "part of an ongoing drive toward creating a richer, more immersive virtual environment". This may as well open the way for Second Life to become a potential upcoming competitor for VoIP providers (such as Skype).

4.2.2 Perspectives

Second Life can become a source of income, it may enhance the real-life of disadvantaged people for instance, but it can also lead to addiction or social problems if the virtual life takes over one's real life. Furthermore, increasingly, politicians discover that if they build virtual headquarters in cyberspace, real people will come, as shown by the French presidential election campaign going on in SL.

Scenarios on the future evolution of Second Life range from very positive with virtual reality expanding to regular applications by 2011, the borders between real world and virtual world having largely disappeared by 2012 and people starting switching between real and virtual world seamlessly to engage in activities and accomplish tasks. More pessimistic scenarios[167] on the impact of Second Life on business include failures because of security issues (e.g. spamming), technical issues (infrastructure) and brand issues (e.g. trust).

Three models of evolution are possible:

- Second Life succeeds by itself,
- A consortium takes over (Google, Sony, MTV),
- Second Life takes over other virtual worlds, partnering with MySpace, for instance.

4.3 JOOST

The IPTV market is expected to grow significantly over the next few years and Europe has taken the lead in the global IPTV market, both in terms of subscribers and revenues. The next step will be to mix, match, and combine services on the fly, based on user preferences (what users want from a TV service is more freedom of choice). IPTV gives new players the opportunity to offer and deliver creative programme packaging to consumers.

Joost is an IPTV service based on peer-to-peer (P2P) technology, as opposed to streaming technology. The system is currently in beta testing with an English language version of the service expected to be launch in the course of 2007.

4.3.1 Business model analysis

Revenue generation

Joost is said to ignore two 'established' business models and thus revenue generating options seen as alternatives to advertising i.e.:

- Pay-per-show and then let users download the content (e.g. Apple iTunes, Amazon)
- Streaming-only subscription to "all –you-can-eat" content without leaving users a permanent copy (e.g. Netflix),

on grounds that "TV is not about buying today what you want to watch tomorrow , it's about turning it on and watching".

Innovation in Joost business model comes from distribution of TV content over the Internet on a free-to-view, ad-funded basis. Video-on-demand (VoD) capability would be rolled out at

[167] Arvetica organized and hosted a brainstorming session on “Second Life for Businesses” within the LIFT’07 conference; see slideshow at http://www.arvetica.com/archives/2007/02/08/lift-conference-07-workshop-arvetica-second-life-for-businesses

some point in the future. Joost plans to offer content owners the option of either selling their own advertising or having Joost sell advertising on their behalf in return for a higher percentage of revenues.

Content creation

In February 2007, Joost announced a partnership with Viacom for making available online content from MTV Networks, BET, and Paramount Pictures. Currently, Joost has as much as 23 channels (incl. commercial content), dedicated to music videos, documentaries (e.g. National Geographic), and live performances. Disney is considering distributing its content through Joost. Joost is therefore not a content creator, however creativity lies in the innovative distribution model, content unbundling/packaging and new type of user experience.

Content distribution

Technically, Joost is a hybrid Peer-to-Peer (P2P) distribution technology i.e. Joltid's 'Global Index' software with a P2P video streaming layer added on top of that core technology. Unlike typical P2P services, Joost uses a streaming-only approach which does not allow users to download content on their PCs. As a result, Joost is focusing on TV content rather than movies. Joost's founders claim that nearly 90 percent of its infrastructure is the product of open source code. X.509 encryption is built in which allegedly turns Joost it into a "piracy-proof Internet platform".

User interaction

The Joost 'vision' is to create the user-built television experience: 'people like the freedom of choice and like freedom from choice'. Widget extensions set Joost apart from other IPTV providers. They add extra, non-television functionality to the Joost program, offering a social aspect to Joost, allowing users to interact with the content and with each other.

4.3.2 Perspectives

Whether Joost will live up to the promise of delivering full screen, uninterrupted streaming video at a decent quality depends on a number of factors:

(a) Joost's capability to create a new distribution channel for premium content
(b) It is unlikely that Joost will tap into user-generated content, partly as to differentiate it from YouTube, but mainly to avoid copyright infringements
(c) Answering the need for bidirectional connectivity to deliver TV experience on a computer
(d) User bandwidth is a critical factor for Joost to succeed in the mass market
(e) Interface design is non-traditional: DVD style and use of widget extensions which add extra, non-television functionality to the Joost program conferring Joost social networking elements, allowing users to interact with the content and with each other

Some possible futures[168] of Internet television have been imagined:

Scenario 1 - The Internet TV box boost

In 2010 Big TV manufacturers like Samsung, Philips, Sony and JVC works together with the internet TV box and put it inside the Flat screen TV's. After 2011 Interactive TV becomes a commodity.

Scenario 2: Internet domination

TV in 2010 may still look as an ordinary TV, but it can also connect to the internet and browse the web as well. Programs of TV channels are mostly online and free to be downloaded and watched by users. Year 2015 is a year of true revolution. Internet TV finally becomes mature. User can watch Internet TV now real time!

Scenario 3: Traditional TV co-exist and co-evolve with Internet TV

By 2013~2016, customers still rely on cable, satellite or TV but more and more interactive internet technology is available.

4.4 MOBILE CONTENT

The European mobile landscape is characterised by a high penetration, sometimes exceeding fixed line access (e.g. in Greece), a 100% SMS compatibility, with 70% of the European population having colour, web- enabled phones, 65% having camera phones and an estimated 60% likely to have a 3G phone by 2010 (Forrester Research). 30% of subscribers change network operator each year, typically changing device at the same time.

Good mobile infrastructure in Europe is helping to build a robust mobile content marketplace. At the same time, Europe is facing problems like diverging and thus confusing mobile data pricing and data tariffs structure (ScreenDigest 2006), lock-in of customers, closed publishing systems ("walled garden"), handhelds design which limits the user experience (small screens) as well as DRM regulation which prevents content from being used on other devices.

4.4.1 Business model analysis

Revenue generation

In terms of creative content, the mobile market is expected to see growing revenues in particular from music downloads, mobile TV and mobile games.

Mobile music downloads is currently the fastest growing segment in the digital music downloads market (revenues from downloads of full track songs on mobile networks were €76.3m in 2005, with the UK being the biggest market (€28.2m) - IFPI).

Technology consultancy Strategy Analytics predicts that mobile firms will have about 50 million users of mobile TV by 2009, generating an estimated £3.5bn in revenue.

[168] Developed by **ScenarioThinking.org** open community on scenario thinking and scenario planning currently sponsored by Daniel Erasmus and the Digital Thinking Network

Content production

Mobile content producers are typically small, specialist start-ups, however many 'traditional' media companies have moved into mobile content either by setting up mobile divisions or through acquisition of small companies.

Mobile Music is currently mainly about ringtones and more recently ringback tones.

Main genres for *mobile TV* are quizzes, comedy and reality shows, and sport. Mobile TV´s early uptakes are encouraging. It is predicted that TV tuners on mobile will become prevalent on advanced handsets (e.g. DAB for Virgin Mobile). Operator 3 in UK has already begun experimenting with user generated Content.

Video calling is not yet mainstream; bandwidth cost and availability are main barriers to adoption. The *mobile video* market is still limited to video clip downloads while video streaming depends on 3G availability.

Content distribution

An increasingly diversified and high quality multi-channel TV offering, the deployment of VOD on cable and ADSL networks and the beginnings of HD TV are some of the drivers in the *mobile TV* sector. Challenges include new internet practices which are likely to revolutionise the world of TV (Blogging, Vlogging and podcasting spread in the USA, the number of video search engines rises, the emergence of TV Peer-to-Peer networks) as well as media consumption habits which grow increasingly complex but change slowly.

For *mobile games* Java is the established platform in Europe. Multi-player games on mobile have not taken off in Europe (some exceptions apply e.g. Vodafone allows for multiplayer-games on handsets). The main barriers for adoption are the platform segmentation and cost of data connection.

User interaction

As opposed to Internet users who expect content to be free, mobile users expect to pay for content. Consumers want content allowing them to "virally" express themselves i.e. pass to friends, which is best achieved with "consumer-ready" content where no input is required from consumers. Tools for personalisation of viral content are needed. Mobile phones are part of people's daily lives – they are a "must have", a fashion accessory and a social enabler, as well as a "social lubricant" i.e. facilitating interaction.

Music and video are DRM protected so they cannot be forwarded on mobile. Consumers increasingly demand unlocked content that works on any kind of devices (MP3 player, PC, Mobile etc).

In terms of user preferences in the *mobile TV* segment**,** TV "snacking" seems to be most popular at the moment (e.g. during lunch/breaks, while travelling to and from work, while queuing or waiting for friends).

Mobile 2.0 brings together Web 2.0 and the mobile platform to create a new class of services that leverage mobility such as pictures taken with camera phone and automatically uploaded to a photo sharing service via a photo upload application downloaded over the mobile Web (no need of a PC as an intermediary). The trend towards Mobile 2.0 is linked to the growth of user generated content, the emergence of mobile blogging (camera phones pictures added to blogs on mobile & fixed internet sites via MMS) and mobile radio played on the go (e.g. shows downloaded weekly to handsets) and enhanced by the availability of TV tuners on advanced mobile handsets (e.g. DAB for Virgin Mobile).

4.4.2 Perspectives

Mobile has the potential to become a credible alternative to Internet: a mobile phone is always on; it is a device through which access can happen anytime and from anywhere. However the following issues needs to be tackled if mobile platforms are to deliver their promises:

- Existing web content to be re-purposed for mobile (e.g. in order to look good on mobile screen),
- Capabilities required for accessing the incremental web (real-time web),
- Disruptive technologies & applications (e.g. user-generated content),
- Meeting customer demand for 3G services,
- Service mix and pricing,
- Fixed–mobile substitution,
- Fixed–mobile convergence,
- Wireless infrastructure developments (including Super 3G/LTE, DVB-H, WiMAX and 4G),
- Handset and terminal design,
- Competition, regulation, industry structure and value chain organisation.

5. WAY FORWARD

This first analysis of the creative content industries has shown that tremendous changes are currently underway, resulting from the influence of technological and social developments in particular and leading to challenges for all actors in the sector. Rather than providing answers to future evolution, we have arrived at a number of questions which we propose to address using a participatory tool, in this case an online Delphi. By inviting experts in the field of creative content to participate in this exercise, we should be able to collect views and visions so as to define possible scenarios for the creative content sector evolution. Based on those, specific challenges will be highlighted that require the attention of policy makers, helping to define strategic priorities in particular for R&D policy.

The questions we have come across relate to three main elements of the creative content industry value chains, namely **creation** and **distribution** of content as well as **user interaction**. Those deserve specific attention along with the more general issue of **challenges and opportunities** facing the sector.

On content creation:

- How to foster creation, creativity, talent?
- How to develop cross-disciplinary skills?
- What are the challenges for content creation?
- How to involve creators in the innovation or R&D process?
- Is diversity a strength and how should it be exploited?
- How to foster the development of creative content for edutainment or lifelong learning purposes?

On content distribution:

- What is the role or impact of technologies on the value chain for specific sub-sectors (e.g. music, cinema, video, games, books, newspapers, etc)
- Is technology really a driver, a push factor?
- What are viable multi-channels delivery models?
- What is the role of market size in different industries at global, national, regional, local levels?
- What should be done to develop European aggregators?

On user interaction:

- What impact does the "prosumer" or user-creator have on current business models, on development of technologies, distribution system and innovation?
- How to take advantage of user creation? How to foster it (e.g. tools)?
- How to build on social networks to develop sustainable business models?
- How to enhance the user experience? How to address user expectations?

On challenges and opportunities for the creative content sector:

- What technology areas are expected to have a potential for significant impact on the Creative Content industries y in the coming 5-10 years?

- What type of impacts is expected, resulting in new business model, changing the way of creation and distribution of content, customer/user interaction?
- How will the convergence of technologies determine the future of the industries?
- How to create lead markets? What are the emerging areas with a good growth potential for European companies and markets, technology and/or market niches?
- How to foster a risk-taking mindset in Europe?
- What should be done at EU level to encourage the set-up of incubators (i.e. enabling SMEs to use the infrastructure from large operators)? of innovation ecosystems facilitating cooperation?
- How to help national successes make it across borders within the EU?

In a second step, we deem it necessary to address key themes that have emerged from our analysis:

New distribution channels

- Are Internet modes of distribution of audiovisual content (including illicit copying) likely to provide a serious challenge to video on demand offered by cable and satellite network operators?
- Would online distribution of films substantially (i.e. sufficient to enhance the sustainability and vitality of producers and publishers) enhance the market for those European films that are not at present entering international distribution channels? What about the use of social channels
- What barriers exist to the uptake of MMORPGs (massively multiple online role playing games) in a European context?

New consumption patterns

- How important is online (accessed using the Internet rather than local area network or personal computer mass storage) likely to be to users five years from now?
- Is the current interest in self-produced audiovisual content likely to be passing 'fad' or 'fashion' and the audience in terms of numbers and viewing time will be dramatically lower in five years time?
- Does production of creative content by those not expecting direct payment for its use or reproduction constitute a significant threat to the revenues of creative content publishers who do expect direct payment? If so, share of total 2010 revenues might be diverted by this source alone (neglecting copyright infringement)?
- Will the technological possibility of electronic monitoring of audiences alter the presentation of creative content? If so, how?
- Will artificial worlds such as Second Life continue to generate larger 'online economies' which have real monetary value?

Technology evolution

- Would improving the inter-operability of the gaming capacities of mobile telephone handsets substantially (i.e. sufficient to enhance the sustainability and vitality of producers and publishers) influence market growth for mobile game producers and publishers?

- Is there a realistic prospect for a European-wide standard for content storage? Failing that, is there a realistic prospect for European-wide standards for classification techniques? Would public research funding aid in this process?
- Will MMORPG continue to be 'scalable' with increased use or will they encounter irremediable congestion effects?
- Will the capabilities of 'intelligent agents' improve sufficiently in the coming decade that users will rely upon them for acquiring and assembling a significant amount of the creative content that they consume?
- Will speech and language interfaces be improved sufficiently in the next decade that they become a preferred means to interface with electronic devices a) in mobile applications, b) in desktop applications?
- When will desktop animation make it possible for users to produce their own dramatic performances? When will this be possible using characters that are difficult to distinguish from human actors?

Mobile content

- Are mobile phone platforms likely to be able to compete robustly with dedicated portable music players? If so, what is the relative importance of a) expanding their storage capacity, b) enhancing services for selecting music online, and c) creating more effective means of linking mobile phones to personal computers?
- To what extent will mobile users wish to consume audiovisual content on the move?
- If mobile audiovisual is to become important is it likely to resemble television or to involve different programming and production methods?

Piracy

- Is the view that illicit digital copying of music has been 'contained' and is likely therefore to decline in coming years valid?
- Would a system of collecting royalties on online distribution of audiovisual content be preferable to efforts to curtail this practice by pursuing those practicing it? If so, would such a scheme be feasible and how might it be funded?
- Will the distribution of copyright information on the Internet continue to be a possible source of civil or criminal liability in five years time a) for individual users not making any revenue through the activity, b) for those making revenue from the activity?
- Is copyright infringement in the soundtracks of user-produced videos likely to create a major conflict in the next one to two years?

Heritage and cultural diversity

- Is Europe lagging behind or in advance of the US in the creation of online access to museums and libraries? What areas should be seen as high priority for further action?
- Would public research funding assist in improving the experience of making 'virtual visits' to museums and other cultural resources (i.e. is there a realistic prospect that research will be translated into use)?
- What, if any, policies might slow the decline of independent book sellers (offering both new and used titles) in order to preserve their role in promoting variety. Correspondingly, do independent book-sellers offer a meaningful source of variety

given the emergence of both mass and specialised sources of Internet information on books?

ANNEX 1 – CASE STUDIES

1. SOCIAL RADIO (PANDORA, LAST.FM)

What we can learn from community-based Internet radio and music recommendation services (examples: Pandora, Last.FM etc.)

European music market is the second largest music market worldwide (32.5% of sales) after USA with the UK being the most important market in Europe (and third worldwide). Digital music sales have doubled in value in 2006 with 50% of them through mobile (90% in Japan!). After several years of heavy promotion, digital sales made up only 10 percent of total music industry revenue in 2006, according to an IFPI report.[169] Analysts[170] predict that paid-for digital downloads may not live up in the long term. Record companies have started to investigate other alternatives to generate revenues such as for instance, teaming up with community- based sites such as Pandora and Last.fm. Radio is still the most important medium for music distribution regardless of the recent growth in online distribution. Radio "spins" usually result in increased physical or digital purchases, driving interested consumers to retail outlets / digital stores like Amazon or iTunes stores (e.g. Pandora).[171]

Some facts-based evidence

PANDORA

Pandora is a music streaming service (so-called "music discovery" system) that relies on user input to build customized, individual stations on-the-fly. It has been launched in the USA in 2005 and it is rooted in the Music Genome Project, which began in 2000. Pandora reported 4.5 million users in Nov 2006 (currently only available to U.S. residents). In October 2006 Pandora claimed about 2.2m unique visitors to its website (less than Last.fm's 5 millions in the same month – see below).

Content creation: User is a creator: of radio stations, of recommendation / taste (Pandora is playing songs based on the tastes of other listeners who also like that artist), feedback (user feedback used for future selections).

Content distribution: Through the music recommendation system, artists can be discovered more easily and they are less reliant on the record companies. Their critical mass drives up e-music sales further (listeners can buy the music they hear by going to Amazon and iTunes).

User interaction:

Some additional features aim at increasing interaction among members (listener profiles with musical preferences, listener search and lists of users who are fans of particular bands).

User' feedback influence the selection mechanism by which new tracks are added to the radio station.

[169] 2007 Digital Music Report available at http://www.ifpi.org/content/library/digital-music-report-2007.pdf
[170] Forrester Research for instance
[171] OECD Working Paper on Music industry based on Jupiter Research report, 2004

Revenues

Revenue streams come from free subscription supported by ads and fee-based subscription without ads (the first 10 hours of Pandora are free ad-supported, after that subscriptions costs $3 per month or $36 per year). Pandora has also referral revenues (links to Amazon and iTunes so users can buy the music they hear). In Feb 2006, Pandora reached agreement to licence content from Orchard.

In Jan 2007, Pandora experimented a NPR (National Public Radio)-style ("this station brought to you by McDonalds...") ad-based streams as to allow users to listen to free music so long as they agree to listen to advertising also.

LAST.FM

Last.fm is an internet customised radio station and music community site. It was founded in 2002 by Felix Miller, Martin Stiksel, Michael Breidenbruecker and Thomas Willomitzer (all from Austria and Germany); it merged with Audioscrobbler (born in UK) in August 2005. Last.fm has a growth rate of 15 thousand active users per month. Last.FM had 5 million unique visitors in October 2006 according to Comscore and was reported as having catalogued 65 million tracks from 7 million artists in Nov 2006.

Content creation:

User is a creator of: recommendation/taste; connections ('friends' system; formation of user groups between users with similar tastes); tagging (user-end tagging of artists, albums, and tracks).

Content distribution

Last.fm also makes users' listening habits accessible via an RSS feed.

User interaction

Last.fm is socially driven, while Pandora is driven by trained music analysts, who classify music first before it can be listened to on the radio. It is a music community site, where users can form "communities of interest" sharing similar music tastes as well as join discussion forums and a wiki space.

Revenues

Revenue streams come from subscriptions (no ads). Until October 2006, Last.fm tracks were offered as a free download service (from Oct 2006 onward, only possible for tracks on indie labels or for uploads by bands themselves).

In December 2006, EMI Records teamed with Last.fm and launched 'tuneglue-audiomap,[172] an extensive online music mapping mechanism which uses Last.fm to make focused and accurate music recommendations.[173] This user-generated music map links consumers to recommended artists, websites and retailers, based on the comparison of the listening preferences and profiles of other music fans.

[172] http://audiomap.tuneglue.net
[173] EmiGroup press release

As from Feb 2007, Warner music will be made available via Last.fm in Europe and USA. As part of the partnership, Last.fm will have access to Warner's catalog through Last.fm's free, advertising-supported radio streaming service and its soon-to-be released premium subscription-based interactive radio.[174]

Expanded catalogues and the addition of exclusive major label content would increase traffic and may provide Last.fm with a competitive advantage.

Lessons to learn

Content creation and the role of the user

Users are becoming deeply involved the process of production and service innovation.[175] First, the user is the supplier of content. E.g. in Pandora and Last.fm, the user publishes and shares content, taste/recommendation, and contacts. Then, it is deeply involved in the design and production of the service (users' feedback and recommendation contribute to further features). In Last.fm for instance, users can customize the radio. Social radio blurs the disparity between (users) amateur listeners and professional broadcasters.

User interaction

There is a shift from the passive role of the user, inherent in the television culture, to an active one, essential to the web culture (from consumption to participation). The user plays a central role in finding/ selecting/filtering the content. Tagging and taste-sharing help on sharing information and content. Content becomes easily accessible through social context. People are building new social ties and new social networks (e.g. communities of interest).

Content distribution

These services provide a lower barrier to entry for artistic creation and lower costs of finding new talent. Through the music recommendation system, artists can be discovered more easily and they are less reliant on the record companies. Their critical mass drives up e-music sales further (listeners can buy the music they hear by going to Amazon and iTunes).

The "economy of abundance"[176] is challenging for businesses; the abundance of information causes scarcity of attention on the users' side and in turn, has consequences along the value chain. Recommendation systems like Last.fm or Pandora address the relevancy issue i.e. showing the user relevant content by generating relevant, personalized content, based on user preferences (e.g. the music you are listening to). Recommendation systems address the relevancy issue (i.e. showing the user relevant content) by generating relevant, personalized content based on user preferences (e.g. the music or news etc you are listening to or watching at etc). Some approaches fall into either personalized recommendation (based on the individual's past behaviour) or social recommendation (based on the past behaviour of similar users) e.g Amazon, or music recommendation sites like Last.fm, Pandora. The economics of the web and information explosion are driving us towards a so-called 'attention economy'.[177]

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[174] Source: Warner Corp. Feb 2007

[175] In 1976, Von Hippel published its seminal work on innovation.

[176] See for instance Chris Anderson of Wired blog at http://www.longtail.com/the_long_tail/2006/10/the_economics_o.html

Herbert Simon was perhaps the first to articulate the concept of attention economics when he wrote "...in an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it is that information consumes. What information consumes is rather obvious: it consumes the attention of its

Retailers have a big incentive to provide recommendations to those users who are "just browsing", to drive them towards a transaction. However, issues like standards and infrastructure for building attention services need to be addressed.

Different users' mindset involve a shift in business models i.e. addressing the middle part of the Long Tail (i.e. making a business less dependent on catching the big hits) and addressing the shift towards participation and new community practices.

Radio broadcasters are struggling to adapt. BBC plans to allow audiences to create personal radio stations from its content. The service, provisionally called MyBBCRadio, aims to give audiences more control by combining existing services such as podcasts and the BBC Radio Player. It will be part of the BBC's iPlayer, a new interface device that shall transport custom content (music, video, reports) to each user. MyBBCRadio would use peer-to-peer technology to provide "thousands, ultimately millions, of individual radio services created by audiences themselves".[178] The new service will also track what listeners like to suggest similar music tracks and other content.

Business models

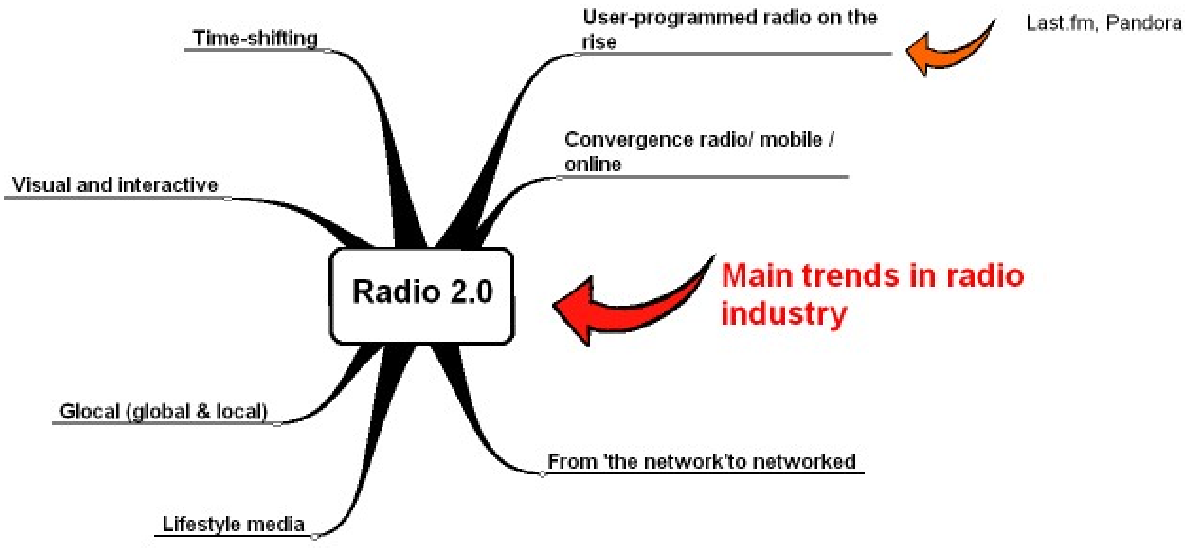
Pandora and Last.fm are anxiously trying to find and adopt a sustainable business model. Whatever the model chosen, subscription or advertisement, such services will have to make a trade off between generating revenue and getting the user back into re-using the service. However, the implications of the subscription-based online radio are still unclear. Screen Digest believes[179] that it is not likely to gain much support when compared to the free alternative. IFPI reports as well a slowing global growth of online music subscribers which would support this assumption (3.5m online music subscribers globally at the end of 2006, a net addition of 700,000 in the year, compared to 1.2m net additions in 2005). Some free ad-supported content distribution models have emerged (see chart below for further trends across several industries).

recipients. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it" (Simon 1971).

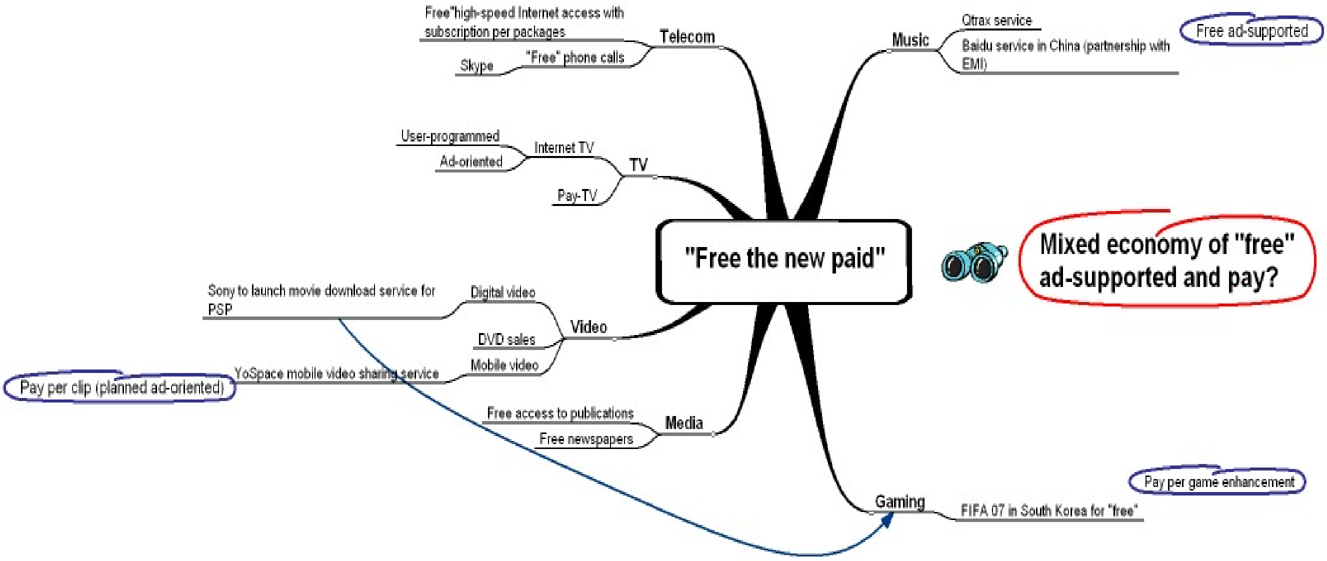
178 Source: BBC

179 Screen Digest Broadband Intelligence, Feb 2007.

Future of Radio (Radio 2.0)



"Free- the new paid"



Source: Based on IHT article

2. SECOND LIFE

2.1 Introduction

Gaming has emerged as an economically enormously important sector with on-line games, mobile games and, perhaps in future, pervasive gaming. Most of the revenues are generated by off-line gaming for consoles and PCs, but an increasing share is coming from on-line gaming (MMORPGS and virtual worlds). Since opening in 2003, one of the most popular on-line games, Secondlife, is played by millions of individuals: the subscriber base for Secondlife has reached its **five millionth** inhabitant (5,179,495 people as of March 2007). Europe has taken lead in Second Life users (54% of active users in January 07 vs 34.5% in USA -Linden Lab data). According to Philip Rosedale, the founder of SL maker Linden Lab, just one in 10 people who sign up use it in any meaningful way (active users). One study extrapolates 25 million total accounts, with 150,000 Residents simultaneously online, by March 2008.[180]

2.2 Business model

Second Life can be joined for free, however some goods and services are payable in Linden dollars. These charges are not included under membership pricing, but are part of the economy of Second Life. There are two types of accounts in Second Life: "basic accounts" and "premium accounts". Basic accounts have no recurring fee, but lack the right to own land within Second Life. As of February 2007, the premium account fee is set at $9.95 per month ($6.00 per month if the fee is paid annually). Premium accounts receive a weekly stipend (L$300 per week as of February 2007)

2.3 Content creation

Second Life is, according to its website, “a 3-D virtual world entirely built and owned by its residents”. In Second Life, the residents create most of the content of the world. The avatars[181] are one example of such user-generated content. A 3D modeling tool allows residents to build virtual buildings, landscape, vehicles, furniture and so on. Any resident can also make *gestures* from small animations and sounds from the standard library. External created graphics, animation, and sounds can be imported into Second Life. Second Life also includes a scripting language called Linden Scripting Language (LSL) that can be used to add autonomous behavior to objects, such as doors that open when approached.

Second Life is also a virtual incubator for innovation and entrepreneurship. Residents create new goods and services, and buy and sell them in the Second Life virtual world. The economy has its own currency, Linden dollars, which can be bought and sold on LindeX, the official Second Life currency exchange, for real currency (exchange rates fluctuate, but remain relatively stable at 250 Linden Dollars to the US Dollar.) Second Life statistics claim that 144,108 customers spent money in-world in December 2006 (SecondLife economy stats).

In terms of copyright protection, Second Life residents have copyright over their creations. An item can be marked as "no copy", "no mod" i.e. no modifications can be brought by others or "no trans" i.e. the current owner of the item may not give it to another person.

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[180] http://secondliferesearch.blogspot.com/2007/03/second-life-residents-statistics.html

[181] An avatar is an Internet user's representation of him(her)self.

2.4 Content distribution

Virtual reality worlds may represent a test bed for experimenting and prototyping new ways to communicate to the market and distribute content online.

Second Life offers its members the ability to spend real-world dollars on both virtual and real goods and services. Media companies have 'jumped on the bandwagon' (e.g. with kiosks to promote music and video downloads from real and virtual artists; news from a Reuters virtual news bureau reporting on happenings in Second Life and also include links to Reuters news feeds from the outside world; Second Life residents can stay tuned to the latest headlines by using a feature called the Reuters News Center).

Virtual worlds could transform the way 'real world' businesses operate e.g. from training and collaboration to product design and marketing. Companies like Reebok have a positive corporate presence with boutiques where they can not only make a little money but also promote their brands to Second Life residents who might then be more inclined to be customers offline too. New virtual worlds create significant revenue opportunities for service providers to link their networks to these social network environments. For instance, IBM demonstrated a new technology platform that enables instant messaging to flow between and mobile phones and also enables users to create voice conference calls while in Second Life meetings.

Brands creating a presence in Second Life will shortly be offered measurement tools to monitor the effectiveness of their in-world investments. For instance, Electric Sheep Company monitor software for return on investment; distribution of 'virtual products', like Reuters' mobile news reader, as another way to monitor Second Life campaigns.

Second Life has recently emerged as one of the cutting-edge virtual classrooms for major colleges and universities (e.g. including Harvard). When you click on a "play" button in Second Life, video programming from NASA TV appears on the screen.

2.5 User interaction

Within Second Life, there are two main methods of text-based communication: local chat, and global "instant messaging". Voice capabilities may be added soon, as "part of an ongoing drive toward creating a richer, more immersive virtual environment". This may open as well open the way for Secondlife to become a potential upcoming competitor for VoIP providers (such as Skype).

2.6 Some issues

(a) <u>Influence of Second Life on real life</u>

Second Life can have impacts on positive but also negative side. On positive side, Second Life can become a source of income; disabled people (e.g. those mute, paralyzed or with mobility difficulties) can have a "second life" (freely walk or even fly around, have easy conversation with many people).

On negative side, some of the users overcome the physical and psychological limitations. Too many hours at play have been seen to lead to physical and psychological health risks. An exaggerated example is the gamer in South Korea who died after playing an online game for 50 hours with a break. This may also raise social problems that go beyond physical health i.e.

addiction. At one point the Second Life can become the first life. People neglect sleeping, eating, working. They loose contact with their families, real life friends.

Just like in the real life, Second Life is not "for free". According to FT, a US Congressional Committee was looking into the possibility of how better to levy taxes on the virtual income from economies like that of Second Life.

(b) "Shock the avatar"

Nicholas Carr, former executive editor of the Harvard Business Review, talks about an experiment run by academic researchers in which participants were asked to give increasingly strong electric shocks to an avatar. The researchers concluded "Our results show that in spite of the fact that all participants knew for sure that neither the stranger [the avatar] nor the shocks were real, the participants who saw and heard her [the avatar] tended to respond to the situation at the subjective, behavioural and physiological levels as if it were real."[182]

(c) Infrastructure

(d) Next generation of Internet-based campaigning

Increasingly, politicians in France and across Europe are discovering that if they build virtual headquarters in cyberspace, real people will come. All four major candidates in France's presidential election have opened virtual headquarters in Second Life. It allows inhabitants to engage in debates, attend political rallies and take part in protests in a multidimensional world. "We reach people who wouldn't have gone to meetings or rallies," said Gandelon, Bayrou's Second Life coordinator. "We talk to a lot of undecided voters and also activists from other parties". Campaigns report that Second Life has estimated daily visit numbers of up to 20,000 for Ségolène Royal, 11,000 for Le Pen, 10,000 for Nicolas Sarkozy and 7,000 for François Bayrou. Campaigning problems have started to be encountered. "The headquarters are so open that we see extreme behavior," said Loic Le Meur, a French blogger who helped open the virtual office of Sarkozy on Sarkozy Island, where campaign volunteers hand out virtual T-shirts and pizza to visitors.

2.7 Scenarios on the future evolution of Second life

As the amount of users of Second Life would keep expanding, people would become more and more familiar with the concept of it and its possibilities. This would make Second Life into one of the new "next big things" that more and more users and companies would be interested in joining. In a very 'bright' development scenario[183] **for instance,** Second Life becomes First Life…

By 2011, the use of virtual reality catches on with the masses. This creates new possibilities (but also new competition) for Linden Labs. Virtual Reality starts expanding to regular applications. Ideas of complete virtual offices, classrooms, etc. start emerging. The Second Life world by now is starting to become a perfect mirror of the normal world. By 2012 the borders between real world and virtual world have largely disappeared. People start switching between real and virtual world seamlessly to engage in activities and accomplish tasks.

[182] Nick Carr's blog at http://www.roughtype.com/archives/2007/01/shock_the_avata.php ; article at http://www.plosone.org/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1371%2Fjournal.pone.0000039

[183] See http://scenariothinking.org/wiki/index.php/The_future_of_Second_Life_in_2012#Scenarios

People's "First" and "Second" life have almost merged. Walking around in Second Life is more and more considered a "real" experience. The integration of Second Life into the lives of their user base is almost complete. With this, Linden Labs starts targeting even more to people who are harder to reach (like the elderly, people who dislike technology, etc.) with the goal of reaching almost every one that can use a computer. As Virtual Reality is now a normal part of life, more money is spent on researching new ways of experiencing it (like smell, taste etc.).

Companies began experimenting with the possibilities of Second Life and start offering a few services to their costumers. Possible development scenarios[184] for the impact of Second Life on business:

(a) Dec, 2008- In an interview with the Financial Times (FT) Sam Palmisano (CEO, IBM) explains to the newspaper why they fell for the Second Life fad and lost $ million US 85 of investment in the process.

Under this scenario, Second life failed because of security issues (e.g. spamming), technical issues (infrastructure) and brand issues (e.g. trust).

(b) Dec, 2008: The Financial Times (FT) publishes an article stating that Second Life is business as usual and that 85% of all Fortune Global 500 companies have established a major Second Life presence.

Under this scenario, Second Life opens new possibilities in terms of interaction and content, it becomes widely adopted by businesses and individuals; regulation and technical problems are addressed.

Three models of evolution are possible:

- SL succeeds by itself,
- A consortium takes over (Google, Sony, MTV),
- SL takes over other virtual worlds, partnering with MySpace, for instance.

At the end all participants voted if Second Life (or virtual worlds in general) was a fad or a potentially important business asset: 7 of the 15 people having participated to the brainstorming do not believe that virtual worlds will play an important role for businesses by 2009 (but in another timeframe); however, 8 believe that virtual worlds would play an important role by 2009, but of these 8 nobody believed that Second Life would be the one;

[184] Arvetica organized and hosted a brainstorming session on "Second Life for Businesses" within the LIFT'07 conference; see slideshow at http://www.arvetica.com/archives/2007/02/08/lift-conference-07-workshop-arvetica-second-life-for-businesses

3. JOOST

3.1 Introduction

According to an iSuppli study, the worldwide subscriber base for IPTV[185] services is expected to expand by a factor of more than 26 from 2005 to 2010. Global IPTV subscribers will grow to slightly more than 63 million in 2010, rising at a compound annual growth rate of 92.1 percent from 2.4 million in 2005, the firm said. The IPTV subscriber base will generate more than $27 billion in overall IPTV services revenue in 2010. The European market has taken the early lead in the global IPTV market, both for subscribers and for revenue. Convergence is a key area driving future innovation in IPTV, where all types of devices will be combined into one interactive platform. IPTV delivers various forms of content (either broadcast TV, VOD, online video, gaming, IM, VoIP). The next step is to mix, match, and combine services on the fly, based on user preferences (what users want from a TV service is more freedom of choice). IPTV is a new opportunity for new players to create a creative packing and deliver it to the consumers.

3.2 Technical background

Joost is an IPTV service based on peer-to-peer (P2P) technology (designed to redistribute video streams on a p2p network), as opposed to streaming technology. The Joost 'vision' is creating the user-built television experience ('people like the freedom of choice and like freedom from choice'). The system is currently in beta testing (40000[186] beta testers worldwide), with an English language version of the service expected to launch in 1Q 2007. Beta testers are also being offered tokens which allow them to invite others to the service, allowing instant access.

From Airwaves to Bitstreams

Companies are racing to put A-list TV on the Net.

Joost isn't the only business trying to bring the broadcast TV experience to the Internet. Even as the networks hammer out their own offerings, upstarts are cutting licensing deals to deliver streams and downloads, clips and full shows—with various plans for making a buck. Here's a quick survey of the competition. —LUCAS GRAVES

	Full Shows	Clips	Streams	Downloads	Revenue Sources	Content
AOL In2TV	•		•	•	advertising	*Babylon 5, Falcon Crest, The Fugitive, Max Headroom*
BitTorrent	•			•	pay-per-show	*24, Chapelle Show, SpongeBob, Laguna Beach, Prison Break*
Brightcove	•	•	•	•	advertising, pay-per-show	National Geographic, Time Life, Warner Music
Google Video	•	•	•	•	pay-per-show	*CSI, Charlie Rose, Star Trek: Voyager, Macgyver, Now*
iTunes Store	•			•	pay-per-show	*Battlestar Galactica, CSI, Desperate Housewives, South Park*
Joost (the Venice Project)	•		•		advertising	*Earth: Final Conflict, Fear Factor, Indie Racing*
JumpTV	•	•	•		advertising, pay-per-show, subscriptions	Sports, news, and music from 180 networks in 60 countries
MediaZone	•	•	•	•	advertising, pay-per-show, subscriptions	Mostly sports, from 100 networks in 12 countries
Peer Impact	•	•		•	pay-per-show	*Babylon 5, Dukes of Hazzard, Flintstones, The Loop*
YouTube		•	•		none	Whatever users upload, plus a special deal with CBS

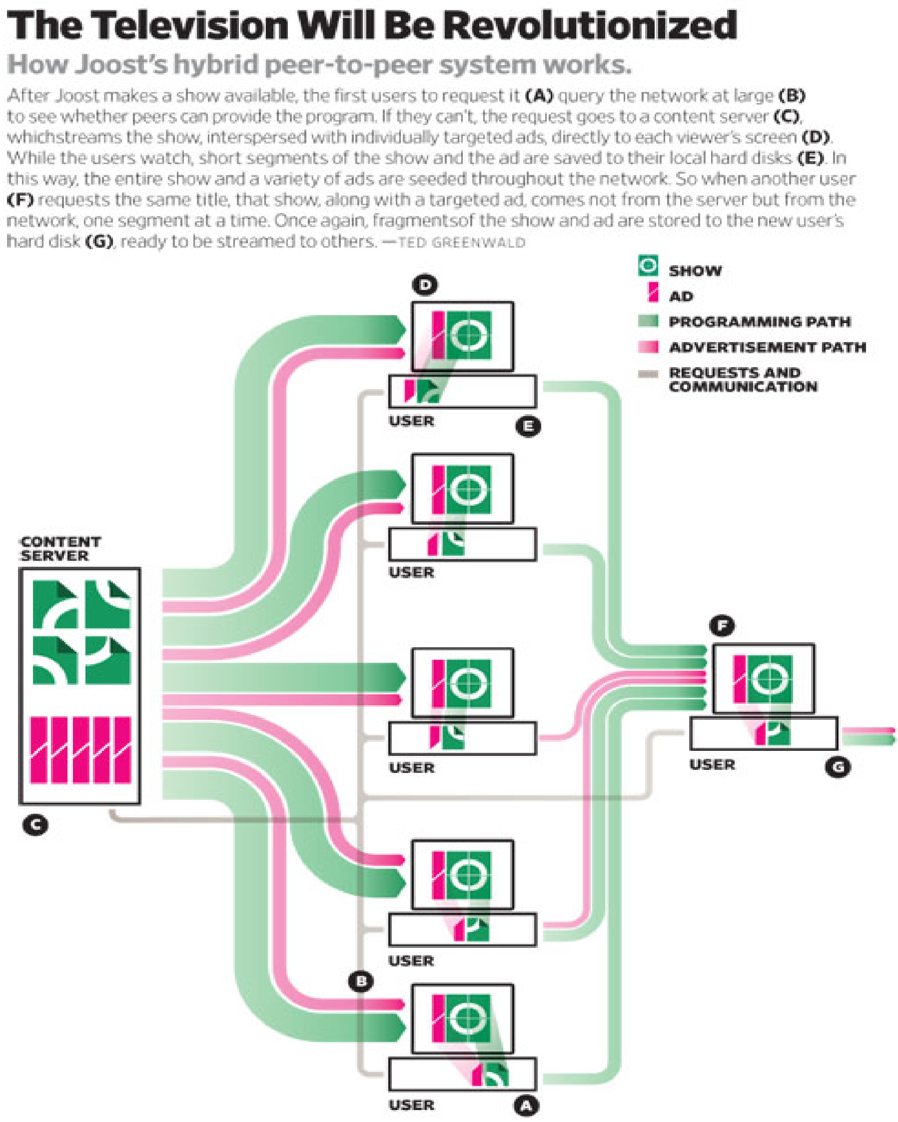
(Source: Wired)

[185] IPTV stands for Internet Protocol Television, a service for delivering digital television over the Internet

[186] CNN money

Technically, it is a hybrid Peer-to-Peer (P2P) distribution technology as Skype, Kazaa i.e. Joltid's 'Global Index' software (owned by a company called Joltid Limited, in which Niklas Zennstrom and Janus Friis, its creators, have an equity interest; nb.: Joltid was not part of the Skype-Ebay transaction), with a P2P video streaming layer added on top of that core technology. Unlike typical P2P services, Joost uses a streaming-only approach i.e. does not allow users to upload content on their PCs, for distribution of content in the most effective way . As a result, Joost is focusing on TV content rather than movies. Joost's founders claim that nearly 90 percent of its infrastructure is the product of open source code.

X.509 encryption is built in Joost (X.509 encryption certificates form the backbone of SSL, an encryption protocol used for everything from Web browsing to sending and receiving email securely) which would turn it into a "piracy-proof Internet platform"(Joost press release).



Source: Wired

3.3 Content

In February 07, Joost announced a partnership with Viacom for making available online content from MTV Networks, BET, and Paramount Pictures.

Currently, Joost has as much as 23 channels (incl. commercial content), dedicated to music videos, documentaries (e.g. National Geographic), and live performances.

Disney is considering distributing its content through Joost. Rumours say that if this becomes reality, it may open opportunities for AppleTV hooking up on Joost.

3.4 Business model

Joost is said to ignore two 'established' business models seen as alternatives to advertising i.e. pay-per-show and then letting users downloading the content (e.g. Apple iTunes, Amazon) and "streaming"-only subscription to "all –you-can-eat" content without leaving users a permanent copy (e.g. Netflix). The reason invoked is that "TV is not about buying today what you want to watch tomorrow, it's about turning it on and watching". Instead, Joost business model innovation is … distribution of TV content over the Internet on a free-to-view (from premium TV programmes to user-generated content, with a particular initial focus on 'mid tail' content owners), ad-funded basis (as short as 'one minute per hour'). Video-on-demand (VoD) capability would be rolled out at some point in the future. Joost plans to offer content owners the option of either selling their own advertising or Joost to sell advertising on behalf of the content owner in return for a higher percentage of revenues.

3.5 Challenges

Whether Joost would live up to the promise of delivering full screen, uninterrupted streaming video at a watch able quality depends on a number of factors:

(a) Creating a new distribution channel for high value (premium) content (what industry calls A-plus content)

Screen Digest believes that the most likely premium content owners willing to sign up will be those without their own major open Internet outlets, such as NBC Universal and Viacom (Fox, Time Warner and Disney have interests in major open Internet distribution outlets e.g. MySpace/FOX.com, AOL/Veoh and Go.com/Apple iTunes).

(b) It is unlikely that Joost will tap into user-generated content, partly as to differentiate it from YouTube, but mainly to avoid copyright infringements

(c) Bidirectional connectivity is needed as to deliver TV experience on a computer (using a PC instead of TV is no much use if changing channels necessitates a return to the keyboard)

It is considered that Apple TV and Microsoft Xbox may offer better potential to 'migrate broadcast TV's mass audience on the web".

(d) User bandwidth is a critical factor for Joost to succeed in the mass market

Joost promises to download around 330Mb per hour for a high quality, TV equivalent experience at high resolution, and it claims that the service can be used by anyone with a broadband connection that is reliably higher than 1Mbit/s .

The average consumer broadband connection in Europe is more likely 1- 2 mbps (e.g. DSL speeds of up to 24 mbps for downloads and 1.3 mbps for uploads are available in UK) which makes it hardly enough for Joost replace broadcast television and also brings up the issue of visual quality.

(e) Interface design is non-traditional (DVD –style with standard video controls; for changing channels, or skip ahead to a specific program and get info about a program or channel).

Widget extensions set Joost apart from other IPTV providers. They add extra, non-television functionality to the Joost program, offering a social aspect to Joost, allowing users to interact with the content and each other: Notice Board (news about Joost), Instant Message (chat with Gmail users from within Joost), Rate (rate programs), Channel Chat (e.g. chat with other users watching the program), News Ticker (an RSS reader that you can use to track outside feeds), and Clock.

3.6 Scenarios for the future of television

Some possible futures[187] of Internet television have been imagined:

Scenario 1 - The Internet TV box boost

In 2010 Big TV manufacturers like Samsung, Philips, Sony and JVC works together with the internet TV box and put it inside the Flat screen TV's. After 2011 Interactive TV becomes a commodity.

Scenario 2: Internet domination

TV in 2010 may still look as an ordinary TV, but it can also connect to the internet and browse the web as well. Programs of TV channels are mostly online and free to be downloaded and watched by users. Year 2015 is a year of true revolution. Internet TV finally becomes mature. User can watch Internet TV now real time!

Scenario 3: Traditional TV co-exist and co-evolve with Internet TV

By 2013~2016, customers still rely on cable, satellite or TV but more and more interactive internet technology is available.

[187] Developed by **ScenarioThinking.org** open community on scenario thinking and scenario planning currently sponsored by Daniel Erasmus and the Digital Thinking Network,

4. MOBILE CONTENT – LANDSCAPE AND FUTURE TRENDS

4.1 Landscape

There is a high penetration of mobile in Europe, sometimes exceeding fixed line access (e.g. in Greece); Europe is 100% SMS compatible , with 70% of the European population having colour, web- enabled phones, 65% having camera phones and an estimated 60% likely to have a 3G phone by 2010 (Forrester Research). 30% of subscribers change network operator each year, typically changing device at the same time.

There is a clear hierarchy of mobile sophistication: in spite of a slow uptake of 3G in Europe (11% by the end of 2005), Europe is currently ahead of the USA in mobile (and 3G) penetration, with Japan leading. Good mobile infrastructure in Europe is helping to build a robust mobile content marketplace.

At the same time, Europe is facing problems like diverging and thus confusing mobile data pricing and data tariffs structure (Screendigest 2006), lock-in of customers, closed publishing systems ("walled garden"), design of handhelds which limits the user experience (small screens) as well as DRM regulation which prevents content from being used on other devices (content is device-locked).

4.2 Behavioural trends

As opposed to Internet users who expect content to be free, mobile users expect to pay for content. Consumers want content that can allow them to ¨virally¨ express themselves (i.e. pass to friends). The best viral¨ effect is achieved with ¨consumer-ready¨ content (no input required from consumers). Tools for personalization of viral content (engagement) are needed. Mobile phones are part of people's daily lives – they are a ¨must have¨ (the ¨mini-Me¨), a fashion accessory and a social enabler, as well as a ¨social lubricant¨ (i.e. facilitating interaction).

4.3 Opportunities

Mobile has the potential to become a credible alternative to Internet: a mobile phone is always on; it is a device through which access can happen anytime and from anywhere.

4.4 Challenges

- Existing web content to be re-purposed for mobile (in order to look good on mobile screen)
- Capabilities required for accessing the incremental web (real-time web)
- Disruptive technologies & applications (e.g. user-generated content)
- Meeting customer demand for 3G services
- Service mix and pricing
- Fixed–mobile substitution
- Fixed–mobile convergence
- Wireless infrastructure developments (including Super 3G/LTE, DVB-H, WiMAX and 4G).
- Handset and terminal design
- Competition, regulation, industry structure and value chain organisation

- Learn from Google platform and apply these lessons to the development of the mobile platform by enabling innovation in an open way (shift from 'walled gardens' towards open platform)

4.5 Who are the mobile content producers

They are typically small, specialist start ups, however many ‘traditional’ media companies have moved into mobile content (either by setting up mobile divisions or through acquisition of small companies: e.g in the mobile games, Electronic Arts acquired Jamdat, Real Networks acquired Mr. Goodliving, Cisco Systems has invested in Terraplay and Indiagames, Time Warner has invested in Glu; THQ, Sony Computer Entertainment and Vivendi Universal Games are ‘traditional’ games companies which have set up mobile divisions).

4.6 European trends across industries

- User generated content
- Mobile blogging (camera phones pictures added to blogs on mobile & fixed internet sites via MMS)
- Mobile radio shows played on the go (downloaded weekly to handsets)
- TV tuners on mobile will become prevalent on advanced handsets (e.g. DAB for Virgin Mobile)

Mobile 2.0 Is Here; it is about services that already exist all around us, maturing at an amazing rate and bringing together Web 2.0 with the mobile platform to create a new class of services that leverage mobility. These services point the way forward for the mobile data industry.

E.g. pictures taken with camera phone are automatically uploaded to a photo sharing service via a photo upload application downloaded over the mobile Web (no need of a PC as an intermediary); a mapping application downloaded on the phone allows for easy tracking routes and access Wikipedia entries for info.

4.7 Personalization

Mobile Music

Internet is an established market for digital music downloads and mobile music downloads is the fastest growing market in this segment (revenues from downloads of full track songs on mobile networks were €76.3m in 2005, with the UK being the biggest market (€28.2m) - IFPI)

Mobile Music is currently focusing on ring tones and more recently on ringback tones. Music and video are DRM protected so they cannot be forwarded on mobile. Content promotions "sniff" handset types in order to deliver content on the most advanced technology which a particular device can manage. Consumers are increasingly demanding unlocked content that works on any kind of devices (MP3 player, PC, Mobile etc). Examples are Lismo in Japan (integrated PC/ mobile player) - mobile as a music player and Verizon Wireless VCast in USA (buy online, play on PC or mobile)

Mobile TV - ¨The next big thing¨

Technology consultancy Strategy Analytics predicts that mobile firms will have about 50 million users of mobile TV by 2009, generating an estimated £3.5bn in revenue. Main genres for mobile TV are quizzes, comedy and reality shows, and sport.

Mobile TV ´s early uptakes are encouraging. It is predicted that TV tuners on mobile will become prevalent on advanced handsets (e.g. DAB for Virgin Mobile). Operator 3 in UK has already begun experimenting with user-generated content.

An increasingly diversified and high quality multi-channel TV offering, the deployment of VOD on cable and ADSL networks and the beginnings of HD TV are some of the drivers in the sector. Challenges include new internet practices which are likely to revolutionise the world of TV (Blogging, Vlogging and podcasting spread in the USA, the number of video search engines rises, the emergence of TV Peer-to-Peer networks) as well as media consumption habits which grow increasingly complex but change slowly.

In terms of user preferences**,** TV "snacking" seems to be most popular at the moment: 36% of Orange subscribers are watching the Orange service during lunch and other breaks; some 18% watched TV while travelling to and from work, 12% while queuing or waiting for friends and 10% watched it at home.

Mobile Games

Java is the established platform in Europe. Multi-player games on mobile have not taken off in Europe (some exceptions apply e.g. Vodafone allows for multiplayer-games on handsets).

The main barriers for adoption are the platform segmentation and cost of data connection.

Mobile video

Video calling is not yet mainstream; bandwidth cost and availability are main barriers to adoption. The Video market is still limited to video clip downloads while Video streaming depends on 3G availability.

4.8 Some glimpses into the future of…

Mobile devices

¨Putting people first ¨ (Nokia 2006) identified four scenarios:

- *¨Achieving together ¨* - <<virtual teamwork>>
- *¨Connecting simply¨* - <<To connect simply is to honour what we value most as humans: staying close to those that matter>>
- *¨Inspiring senses¨* - <<What do our devices say about us? – new forms of personalization>>
- *¨Sharing Discoveries¨* - << People connect through their passions>>

Mobile TV

Scenarios of the future (IDATE 2006) include:

- *"Full freedom TV"* - <<A swift rise of mobile TV on 3G, DVB-H and S-DMB networks>>

- *"Welcome to the world of Egocasting"* << The emergence of universal alternative TV, thanks to the internet and a nomadic TV model based on widespread use of portable digital multimedia players. >>

- *"The reign of the top media brands,"* - <<The rise of non-linear TV viewing, but which nevertheless remains concentrated around the leading media brands' TV portals>>

Institute for
Prospective
Technological Studies

EMERGING TREND UPDATE 2
ICT and the Offshoring of Services

EPIS Work Package 1 – Deliverable 1.2 ETU2

Administrative Arrangement
30-CE- 0070769/00-29

JRC
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ETEPS NET
European Techno-Economic Policy Support Network

IPTS – IS Unit

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** The ETEPS AISBL – European techno-economic policy support network was set up on the initiative of the IPTS in 2005 by 19 effective members from 15 EU Member States. It further counts 19 associated members worldwide and is supported by a network of external organisations. Its main mission is to provide intellectual services for carrying out techno-economic and policy-related studies in the context of EU policy-making. See www.eteps.net for further information.*

EXECUTIVE SUMMARY

Services have long been regarded as non-tradable since they often require that seller and buyer have to be in the same place. Information and communication technologies (ICT) have changed the tradability of many services, in particular of services dealing with the exchange, storage, processing and retrieval of standardized, digitized and codified information. Cheap and fast telecommunication allows that information, once stored digitally, can be transferred and reproduced at zero cost and supports new forms of distant collaboration.

As a consequence, many services previously performed in-house are now tradable and can be delivered over distance. Service provision by parties in a different country, service offshoring and international trade in services has intensified in recent years. Some observers even see a new paradigm emerging that is characterised by offshoring at the level of individual tasks rather than sectors or enterprises with wide-ranging consequences for European economies.

This Emerging Trend Update (ETU) deals with ICT-enabled offshoring of services. We want to show what is currently known about this trend, present figures on the extend of the development, discuss challenges and opportunities for the home countries, ask about preconditions and limits of offshoring and sketch scenarios of the future development.

International offshoring of services is still small, and takes place between OECD countries

Contrary to public beliefs, services outsourcing predominantly takes place at the local, regional and national level and only to a minor part internationally. Services offshoring, where buyer and seller are located in different countries, is still relatively small compared to international trade in goods and represents a small fraction of GDP in most developed countries. Moreover, the majority of service offshoring takes place between OECD countries, and not between developed and developing countries.

Trade in services, however, is rising faster than trade in goods. India, Brazil, Russia, the Baltic states or other countries are seeing a rapid growth in services exports. China is the largest service exporter among developing countries, and service exports in India already account for a higher share of GDP than in Germany, Canada or France.

The empirical evidence suggests that Europe at large is rather a winner than a loser of services offshoring. Balance of payment statistics show that Europe currently has a trade surplus in computer and information services and in financial services, indicating that the EU attracts more service offshoring in these fields than it gives away.

Europe benefits from offshoring; it is not a one-way street

There is a tendency to interpret offshoring as a danger for welfare and employment. This view is not supported by econometric evidence. The current consensus from empirical studies is that there exists no general tendency that offshoring substitutes domestic jobs by foreign employment at the firm level in the long run. Offshoring shifts employment in the home country significantly in favour of high-skilled labour and may reduce employment in the short run; in the long run, parent enterprises benefit from increased overall productivity and from a higher demand for their states of production.

It is, however, necessary to stress that empirical studies deal with average effects of offshoring; they do not state that *everybody* is better off. There are of course, winners and losers of the process; what can be said is that economies in total are better off if they exchange goods rather than produce self-sufficiently. It is important to understand that an increasing level of offshoring will also require changes in skills profiles in ICT industries. Services offshoring will lead to a growing demand for more sophisticated skills levels in Europe and low-skilled jobs will substituted by high-skill occupations due to offshoring.

The potential scope of offshoring is significant, but limited by counter-effects

Despite the current low levels of offshoring, the scope of economic activities that could potentially be affected by offshoring is significant. Estimates say that up to 20% of total employment and up to 80% in some areas such as finance, business and computer services, could be affected.

It seems, however, unlikely that the employment impacts of offshoring will be of the magnitude expected by its main proponents. First, because the types of jobs that are likely to be offshored are also those jobs where Europe can also benefit from offshoring.

Second, estimations of the offshoring potential may underestimate some difficulties: offshoreable service must be delivered in electronic form; information and knowledge necessary for service delivery have to be codified and transferred to the service provider; co-ordination between buyer and seller must be possible by electronic means and last but not least, it must be feasible in terms of cost to have the service performed by a distant agent.

Third, technological change and automation of services may easily erode cost advantages that may have initially driven services offshoring. A high level of innovation in services may contribute to a significant shift in the (labour) cost of service provision. Rather than by offshoring, service activities may therefore be affected by rationalisation pressure. This may equally lead to job losses, but not to a shift of activities to offshore locations. ICT work both ways, i.e. to facilitate offshoring, but also to replace offshoreable activities by automated processes.

Services offshoring is both a risk and an opportunity for Europe

It appears that indeed a high share of services might be offshoreable. Being offshoreable, however, can mean two different things. Some services might be transferred from Europe to other locations, but Europe may equally attract incoming service offshoring from other parts of the world.

Offshoring thus implies both risks and opportunities for service activities in Europe. On the one hand, it implies the risk of job losses; on the other hand, it also includes the chance that incoming services offshoring can be attracted because offshoring is not related to a single country alone.

The advantages of European location are twofold. Trade data suggest that European countries are already doing well in attracting service offshoring in financial and in computer and information services, two areas where Europe enjoys a trade surplus. The financial services sector is an example where Europe already exhibits competitive advantage in international trade, in particular due to the UK financial services industry. Increases in the propensity to offshore in this sector may therefore translate into overall gains, not losses for employment in Europe. However, the rigidities of the European labour markets could result into job losses (see Policy issue *3. Harmonising and flexibilising labour markets).*

Moreover, enterprises in the member states in Central and Eastern Europe are also competitive in more standardized, labour intensive services such as call centres, data manipulation or programming. Their location-related advantages are of course based on wage cost, but not on cost alone. Compared to Asia, they enjoy a more favourable business environment, and geographical and cultural proximity. For these reasons, the CEEC are particularly interesting locations for offshoring by SMEs due to the much lower cultural barriers as compared to Asian destinations.

With regard to language aspects for call centres in particular, one should make a distinction between languages used across various countries (English, French, Spanish and Portuguese) and other languages. Language-bound outsourcing will affect countries like France (e.g. with North Africa) or the UK (e.g. Commonwealth countries) much more than, say, Greece, Denmark or Germany, as the need for translation in the latter would enhance the transaction costs significantly. One of the emerging trends is for call centres to implement VoIP-based platforms which enable on the one hand to reduce costs while VoIP systems may on the other hand offer the potential for language translation services. As a universal translator may not be within reach nor is it likely to be necessary, natural language processing and speech recognition could be combined to offer on-the-fly translation between two to five languages simultaneously.

Scenarios and future strategies

In view of the controversial character of the argument related to the debate of IT services offshoring, there are at least three fundamentally different scenarios that could be envisaged for Europe.

- “Jobs losses, jobs gains”: The first scenario corresponds to the vision of the “great unbundling” as a disruptive process of historical magnitude as brought forward by Baldwin and others. The volume of offshored services will increase considerably. Europe, however, will also develop into an attractive location for inward offshoring.
- “My job went to Mongolia”: The second scenario also assumes an increase in the outgoing volume in service offshoring; the volume of inward offshoring, however, will remain well below expected volumes and European service providers will not manage to compete with Asia, North America or South America.
- “After the Goldrush”: In a third scenario, we describe a situation where the volume of both incoming and outgoing offshoring remains considerably lower than in the two preceding scenarios. Here, a number of factors that hamper offshoring prevent a development as described by Baldwin and others.

Although the three scenario sketches may draw different pictures, in essence the implications and key policy issues are quite similar; they differ only in terms of their magnitude.

From a theoretical point of view, it should be noted that a fourth scenario could be envisaged according to which outsourcing remains weak but "insourcing" becomes very strong. However, as this scenario is very unlikely to materialise it has not been developed in this report.

Two general insights should in any case be kept in mind. First of all, attention should be paid not only to offshoring of IT services to Asia. Instead, the US will remain for the foreseeable future Europe's main important competitor and cooperation partner in the area of knowledge-intensive services. In this area, Europe has a high potential to maintain and further improve its strong competitive position globally.

Secondly, Europe should not regard the growing importance of offshoring in certain types of services as a threat, but rather as an opportunity. It will be decisive both to exploit the opportunities and combat the risks.

Policy issues

1. Open markets, open policy and beyond…

There is nothing which can be won by raising trade barriers and obstacles to the international trade in services. One reason is that one cannot argue against such obstacles if one uses them itself. Furthermore, we see that offshoring also has positive consequences for the home country. Finally, a protectionist policy may at best be a short-term remedy.

On the contrary, Europe should try to exploit the opportunities of offshoring. In this sense, the problem is not offshoring to other countries as such, but the ability of Europe to attract service offshoring from abroad. Europe should try to further strengthen its position as a target region for offshoring. Some countries are already doing very well (Ireland, UK, Baltic States).

2. Fostering innovation in IT services in Europe

Strengthening innovation efforts in IT services will be key for counteracting the potential risks associated with the offshoring of IT services. The development and use of innovative technologies in IT services promises to outweigh the labour cost advantages that still represent the strongest argument for offshoring.

Such a strategy requires above all a dynamic and innovation-friendly environment. This is in itself not a new insight, but it is worth stressing the importance of innovation – and in many instance of research – for strengthening the position of IT services in Europe, especially as it has not been an area of major attention by funding agencies and governments. The creation of sophisticated and demanding home markets for IT services could be an important element of such an innovation-oriented strategy, and an element where governments can exert a strong leveraging function.

3. Harmonising and flexibilising labour markets

There is no doubt that jobs will be affected by offshoring, independently of its magnitude. Even the most positive scenarios will have significant implications on the labour force. Policy makers should not ignore that there will be losers in the process although Europe as a whole seems to rather benefit than suffer from offshoring. The key issue in this context is how to help those who lose jobs due to offshoring find new jobs.

Making labour markets flexible is one means to facilitate adjustment processes. Another important and complementary building block is the flexibility of workers themselves. Workers must be given the means to adjust to new requirements and job profiles. Policy should therefore promote individual skill development, and in particular the ability to learn and re-learn new things. This has far-reaching implications for our entire learning and education systems, from early school age to life-long learning. While this lesson may not be new either, its importance is reinforced by the arguments stemming from the "second unbundling" debate.

4. Expansion and upgrading of the skills base your competencies and skills

There is a clear need for skills upgrading in the home country due to offshoring. Low-skill jobs in Europe can be replaced by flexible high-skill jobs as a result of offshoring only if the necessary skills are available in appropriate quality and quantity. If this is not guaranteed, the potential benefits of offshoring can hardly be reaped. This, indeed, is a critical issue for many European locations.

In order to be able to exploit the potential opportunities, it will be crucial to offer an adequate capacity of highly skilled labour. The skilled labour reserve in Europe is still significant, and extends to as diverse social groups as women, elderly and migrants.

The quality of skills needed to ensure that sophisticated services can be performed in Europe is also changing, similarly to those in the IT industries in general. This goes beyond the usual upskilling argument; also the so-called "highly skilled" will need to adapt to the new requirements resulting from the unpredictable nature of technology and market dynamics in an increasingly globalised and fragmented industrial environment. Hybrid rather than specialised skills, a high degree of flexibility, and the ability and willingness to continuously change personal specialisation and skills profiles are increasingly sought.

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1. INTRODUCTION

1.1 THE TRADABILITY REVOLUTION

The world economy is currently facing an intensification in the division of labour between countries. Indicators for this development are, among others, the increasing volume of international trade and foreign direct investment.

This document deals with one particular trend within the current internationalisation of production, the offshoring of services. This trend is closely connected with Information and Communication Technologies (ICTs) and some of their features.

Trade and production statistics indicate that the production of ICT goods is already highly internationalized: exports of ICT goods amount to roughly half, and imports about 70% of the value added of the European ICT sector (Meijers et al. 2006, p. 91).

But ICT is not only subject to internationalisation and fragmentation; it is also a major enabler of the process. ICTs allow an easy exchange of information between various locations, and therefore help to co-ordinate a geographically dispersed production structure. Information and communication technologies have been identified as key enablers of what UNCTAD (2004) called the “tradability revolution” of services; the term refers to the fact that services have long been regarded as non-tradable since they require that seller and buyer have to be in the same place.

ICTs have changed the tradability of many services, in particular of services dealing with the exchange, storage, processing and retrieval of standardized, digitized and codified information (UNCTAD 2004, p. 148 f). Cheap and fast telecommunication allows that information, once stored digitally, can be transferred and reproduced at zero cost and supports new forms of distant collaboration.

As a result, a number of service activities which have been carried out in-house or by a local supplier can now be organized between distant buyers and sellers. These types of services, as Blinder (2005, p. 13) puts it, "have more in common with manufactured goods that can be put in boxes than they do with personal services”. Examples of such now tradable services are customer care through a call centre, programming, data input, web design, software development, but also consulting or financial services which – in principle - can serve their clients from any location in the world.

This effect of ICTs on the tradability of various services has led authors to assume that a new paradigm in international trade emerges that is characterized by a global division of labour at the level of tasks rather than at the level of industries or firms (Baldwin 2006; Grossman and Rossi-Hansberg 2006a). In the words of Carlota Pérez, “globalisation is not necessarily about moving whole industries or companies to other countries, but rather about disaggregating them and relocating the segments” (Peréz 2006, p. 43).

One possible consequence of this fundamental change is that not only blue collar occupations, but also a number of different high-skill white collar occupations that were protected by non-tradability now face international competition.

We will start our discussion of offshoring by distinguishing various types of distributed and centralized production and the main motives associated with offshoring in section 1.2. Section 2.1 presents empirical evidence on the recent extent of services offshoring. Section 2.2 discusses drivers and motivations for offshoring. In section 3.1 we examine findings on the effects of offshoring on the home countries. Finally, we develop scenarios of the future development of services offshoring in section 3.2. The report finishes with the policy conclusions of section 4.

1.2 Types of Services Offshoring

Despite the prominence of offshoring in policy discussions, there is still a certain degree of vagueness connected with the term. We will classify the various sorts of domestic and international production along two dimensions, ownership and location of activities (Table 1). Similar taxonomies have been employed by the OECD (2004) and the World Trade Organisation (WTO 2005).[188]

A first differentiation can be made according to the degree of internalisation of various production activities in the value chain. We start with the extreme case where a firm produces all its products internally in the home country (*domestic production*).

Table 4: Classification of outsourcing, offshoring and home production

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">Ownership of activities</th></tr>
<tr><th>Internal to the firm</th><th>External to the firm</th></tr>
<tr><th rowspan="2">Location of activities</th><th>Home</th><td>Domestic production (firm produces its products domestically without any outside contracts)</td><td>Domestic outsourcing (firm uses inputs supplied by another domestically based firm)</td></tr>
<tr><th>Overseas (offshoring)</th><td>International production (firm uses inputs supplied by its foreign-based affiliates)</td><td>International outsourcing (firm uses inputs supplied by an unaffiliated foreign-based firm)</td></tr>
</table>

Adapted from European Commission (2005)

If the firm switches from domestic production to using inputs from other domestically based suppliers, we speak of domestic outsourcing. Domestic outsourcing is not a new phenomenon; a more intense division of labour between domestic firms and sectors has accompanied economic growth in Europe and the US over the last 30 years, as can measured by occupational data (Tomlinson 1999). It has been favoured, amongst other factors, by decreasing transport cost, the expansion of the internal markets, and an increased specialisation of firms which allowed dynamic learning effects and increasing returns from specialisation.

The growth of domestic outsourcing has fuelled growth in the business service sector in particular. Manufacturing as well as service firms increasingly utilize services as inputs for their production processes (Pilat and Wölfl 2005). According to an analysis of input output

188 The OECD IT Outlook 2004 distinguishes between domestic supply, domestic outsourcing, international insourcing and international outsourcing. The WTO speaks of captive onshore outsourcing, (non-captive) onshore outsourcing, captive offshoring, and (non-captive) offshoring.

data, knowledge-intensive services are the fastest growing component of intermediary demand in a number of OECD countries (Peneder et al. 2003).

If inputs are delivered from abroad, we speak of offshoring. Offshoring can take the shape of international production, where the firm uses inputs supplied by its foreign-based affiliates, and of international outsourcing, where the firm uses inputs supplied by an unaffiliated foreign-based firm. International production is also referred to as 'vertical' foreign direct investment in the literature (Barba Navaretti and Venables 2004).

The majority of outsourcing still takes place at regional and national level although the scope and volume of international production and international outsourcing has increased considerably in recent years (see next chapter). According to a major survey of firms using eWork[189] carried out in all 15 EU member states and Poland, the Czech Republic and Hungary, 43% of all enterprises do some forms outsourcing of eWork (Huws and O'Regan 2001). 34.5% of the firms do outsourcing within their own region, another 18.3% outsource to a partner located in another region of the home country, and only 5.3% choose a partner outside of the home country. Offshoring of services can therefore be seen as a continuation of long-term domestic trends on an international level.

These results are also supported by a very recent study on outsourcing activities in the Lombardy manufacturing sector (Cusmano et al. 2006). About half of all enterprises provide all service activities in-house, and another 30% in-house and outsourced. Only 5% have outsourced all their service activities. This indicates that "hollowed companies" are still an extreme case of firm re-organisation. Potential service outsourcers consider external service provider mostly from their region (33.6%). Only a small fraction (4.3%) of these potential outsourcers considers international outsourcing.

Key findings:

- Information and communication technologies are a main driver of offshoring and outsourcing because they increase the tradability of many services.
- As a consequence, services previously protected by non-tradability now face international competition.
- Outsourcing of services to domestic suppliers is not a new phenomenon, but a long-term trend and has fuelled growth in business services over the last decades.
- What is new, however, is the fact that services are increasingly supplied over long distances from locations abroad.
- The majority of outsourcing still takes place at the regional and national level.

[189] eWork is defined as any work which is carried out away from an establishment and managed from that establishment using information technology and a telecommunications link for receipt or delivery of the work, see (Huws and O'Regan 2001)

2. PATTERNS AND DRIVERS OF SERVICES OFFSHORING

2.1 THE CURRENT EXTENT OF SERVICES OFFSHORING

It has been noted by various authors that current debates on offshoring are based only on weak empirical grounds and rather reflect vague fears than the actual development (Amiti and Wei 2004; Bhagwati et al. 2004; OECD 2006, chapter 3). This has, on the one hand, to do with the very different definitions of offshoring used in the literature. On the other hand, it is a result of shortcomings and problems in the measurement of services offshoring.

There are currently two approaches to measure the extent of services offshoring. A first approach is to use data on international trade in services, in particular balance of payments statistics. An alternative way of measurement is to calculate the number of jobs affected by offshoring based on assumptions on which occupations are most exposed.

Offshoring measured with balance of payments data

We begin with balance of payments data. Unlike for physical goods, there is no export statistics for services in most countries. We therefore have to rely on data on the payments in exchange of service exports collected by national balance of payments (bop) statistics. Data on trade in ICT-related services can be found in two categories of the bop statistics, "Computer and information services", and "Other business services". The latter category summarizes a number of different knowledge-intensive services such as legal, accounting, advisory, architectural or R&D services.

Balance of payment statistics collected by the International Monetary Fund show the following picture about the international trade in services.[190]

First, developed countries are the most important exporters of services by far and therefore the most important host countries for services offshoring (Figure 1). More than 80% of all service exports originate from OECD countries. These countries are also the main importers of ICT and business services. Service offshoring is therefore predominantly taking place between high-income countries and *not* between high- and low-income countries. This is consistent with data on foreign direct investment in services and other trade data.

Countries such as India, China, Brazil, Russia, Ireland, or the Baltic states are seeing rapid growth in services exports; this growth, however, starts from very low levels and has not yet accumulated to high absolute values. The US, the UK and Germany are the most important exporters of computer and information and of business services in absolute terms.

India and China are still far behind these countries (Van Welsum and Xu 2007). The share of China on the world exports in computer and information services amounts to only 3.5% in 2004, that of India to 2.5%. In relative terms, however, we see that the contribution of exports of these services to GDP is already higher in India than in the US, Germany or France which shows the high benefits India derives from services exports compared to other domestic economic activities.

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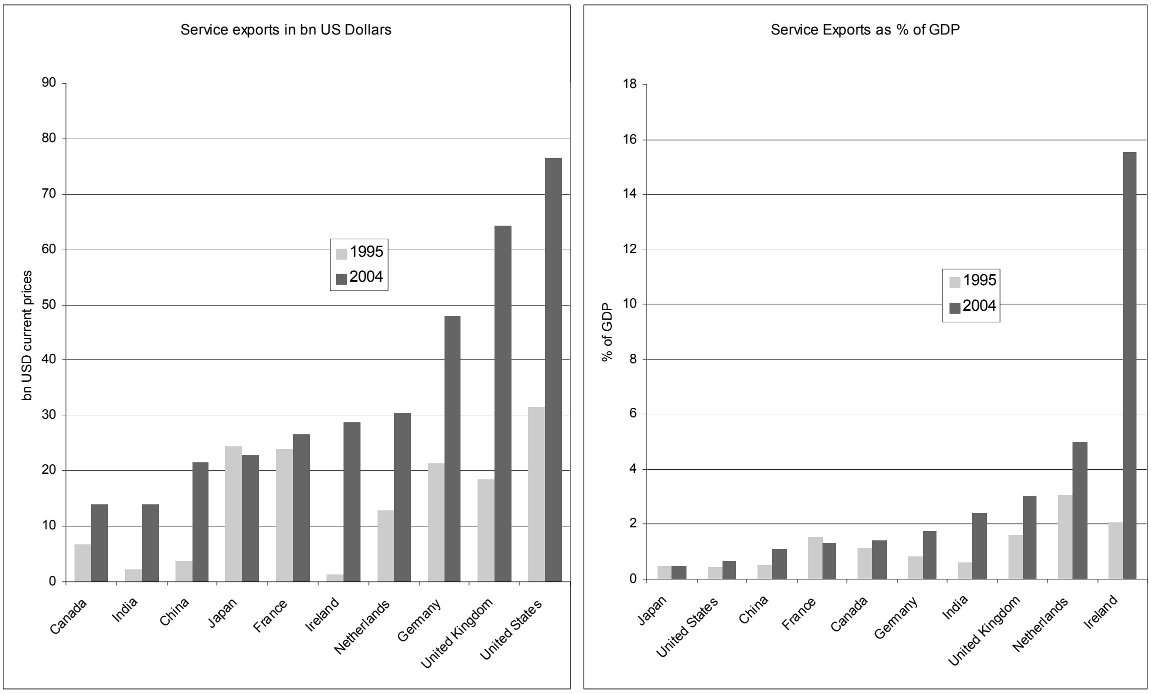
[190] Statistical data have been taken from a recent analysis of the OECD (OECD 2006, chapter 3)

Figure 1: Exports of computer and information, and of business services, absolute numbers and per cent of GDP, selected countries, 1995-2004



Source: IMF, compiled by the OECD (2006); India 2003 instead of 2004

A second result from balance of payments data is that international trade in services is small compared to trade in physical goods. This can be clearly seen in Table 2 which shows some indicators for trade in ICT goods and services between the EU25 countries and the rest of the world. The figures do not include trade between member states of the EU25.

The exports of (physical) ICT of EU 25 countries amounted to 169 billion Euro in 2004, while exports of ICT services reached only a third of this value. Moreover, the shares of imports and exports of ICT services on GDP of the ICT sector are still way below those of ICT goods.

Table 5: EU25's GDP and trade in ICT goods and services

EU25	1996	1997	1998	1999	2000	2001	2002	2003	2004
billion euros									
value added ICT sector (market prices)	175	199	224	245	277	285	293	301	310
idem of % of aggregate GDP	*2.4*	*2.6*	*2.8*	*2.9*	*3.1*	*3.0*	*3.0*	*3.0*	*3.0*
exports of ICT goods	92	110	113	125	168	167	155	152	169
idem as % of GDP of ICT sector	*52.4*	*55.3*	*50.3*	*51.1*	*60.5*	*58.5*	*52.9*	*50.4*	*54.7*
exports of ICT services	19	22	26	28	37	44	47	50	56
idem as % of GDP of ICT sector	*10.8*	*11.2*	*11.4*	*11.6*	*13.4*	*15.4*	*15.9*	*16.5*	*18.2*
imports of ICT goods	116	135	151	178	246	228	208	204	225
idem as % of GDP of ICT sector	66.1	68.0	67.1	72.6	88.6	79.7	70.9	67.8	72.6
imports of ICT services	12	16	19	21	26	30	31	31	32
idem as % of GDP of ICT sector	*6.9*	*7.9*	*8.6*	*8.5*	*9.4*	*10.6*	*10.4*	*10.2*	*10.2*
trade balance ICT goods	-24	-25	-38	-53	-78	-61	-53	-52	-55
Trade balance ICT services	7	7	6	7	11	14	16	19	25
ICT goods: terms of trade	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.4

sources: Eurostat, Balance of Payment Statistics, IMF

Source: Maijers et al. (2006, p. 91)

Both exports and imports of ICT services are growing at a considerable faster pace than exports and imports of ICT goods. Exports of ICT services soared from 19 billion Euro in 1996 to 56 billion Euro in 2004, a similar jump can also be observed in ICT services imports.

Another reason why analysts see only a very small effect of services offshoring on aggregate employment is the fact that offshoring is not a one-way phenomenon from developed to developing countries. Countries import, but also export services, and the net effect of offshoring can only be estimated when subtracting the number of jobs gained by offshoring from the number of jobs lost. This point has been stressed, amongst others, by Bednarzik (2005), Bhagwati et al. (2004) and Amiti and Wei (2004).

The US and the EU are doing very well in exporting business and information services to other regions and both have a trade surplus in the category "other services". A more detailed analysis of this category reveals that the EU15 countries have a surplus in computer and information services, financial services, insurance services and construction services, while they exhibit a deficit in personal, cultural and recreational services, royalties and licence fees and in other business services in the period 1998 to 2003 (European Commission 2005, p. 82). Compared to 1992-1997, Europe could increase its trade surplus to 0.1 % of GDP in computer and information services and to 0.3% in financial services. Figures for the EU25 reported in Table 2 show a similar picture of a positive and growing trade balance in ICT services.

The corresponding data for the EU 10 countries look less favourable. During the period 1998 to 2003 the EU 10 countries have earned a deficit of about 0.8% of GDP in the category other services. However, it also has to be noted that these countries are also among the fastest growing exporters of services and all export and import very few services so far. This deficit may therefore be transitory.

Evidence from balance of payment statistics shows an optimistic picture of Europe's position in the international offshoring of services. Readers, however, should note that the data on international trade in services is subject to some uncertainty. First, it has to be noted that the category 'business services' or 'other business services' is very much a residual in a number of countries. Moreover, it seems that the definitions applied in counting service exports vary between countries. Exports of business services from India, for example, are reported ten times higher than the corresponding import figures of these services in the US, EU, Japan and Canada (OECD 2004, chapter 2).

A second potential source of uncertainty is trade between enterprises belonging to the same multinational company (intra-firm trade). According to the OECD, intra-firm exports account for between 15 to 60% of all exports of foreign-owned affiliates in OECD countries where data is available (OECD 2005a, p. 182).

Intra-firm trade may pose a problem to the proper measurement of services offshoring. Prices that are charged between enterprises belonging to one group (transfer prices) may not correspond to market prices and therefore over- or underestimate the real levels of offshoring. The problem is amplified by the fact that no information on export volumes (weight, pieces etc) is available in the case of services.

Keeping these caveats in mind, we can conclude from statistical data that trade in services is still a rather small, but growing part of the world economy. Contrary to public opinion, offshoring still largely happens between developed countries, and not between developed and developing countries. Europe is rather a winner than a looser of services offshoring. With the exception of other business services which include various consulting, accounting, legal and advertisement services, Europe has managed to maintain its position.

Estimations and projections of actual and potential job relocations

A second approach to measure offshoring is to estimate the number of jobs affected. Such an approach is not undisputed because is rests on rather strong assumptions on how different occupations are effected by offshoring (an example of such a list developed by van Welsum and Vickery (2005) is in the Annex).

Nevertheless, projections of potential employment losses created considerable attention, in particular in the US (Mankiw and Swagel 2006). Most prominent have been the numbers provided by Forrester Research, a consulting company. Forrester Research estimates that 850.000 US service jobs in manufacturing in service industries have been outsourced by the end of 2005, and a total of 3.4 Mio jobs will move to locations outside the US until 2015 (Forrester Research 2002, 2004; Kirkegaard 2004). Goldman Sachs, an investment bank, calculates that between 2000 and 2004 10,000 jobs per month have been moved from the US to overseas locations, and estimates that the number will increase in the future (cited in Mankiw and Swagel 2006).

The consulting company McKinsey estimates that, as an upper bound, 11 percent of worldwide service employment (161 million jobs) could be offshored to low-wage countries by 2008 (cited in Hovlin 2006, p. 20). However, McKinsey estimates that only 4.1 million of these 160 million jobs will actually be moved. The estimate for Europe is 1.2 million jobs. McKinsey estimates that the propensity to move jobs is higher in the UK while countries like France and Germany are slower movers in services offshoring.

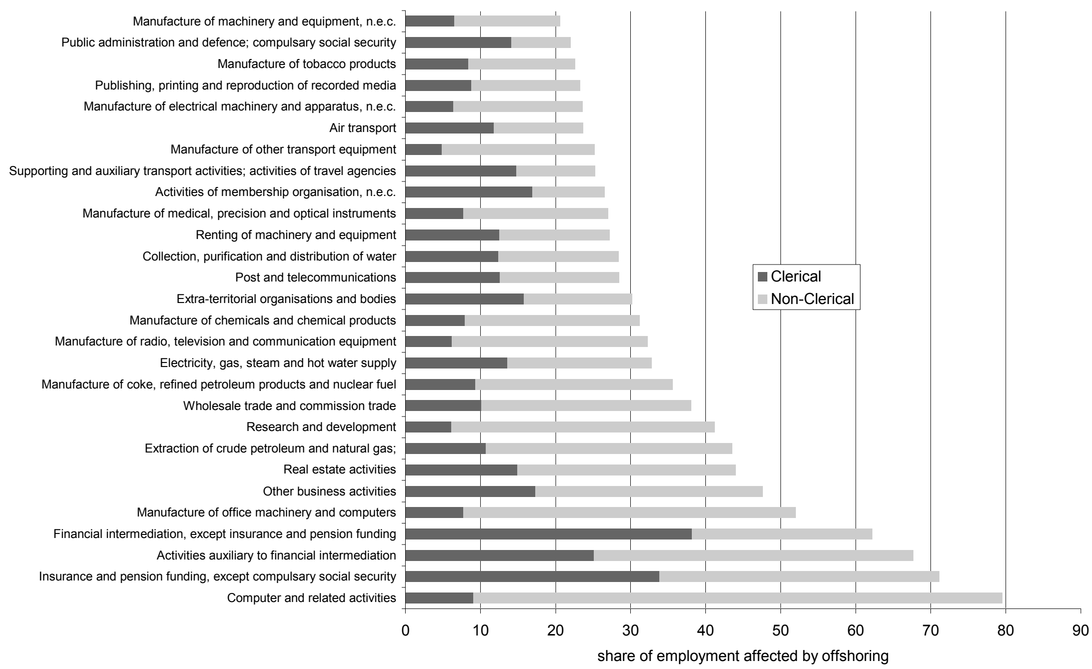
Estimations of service offshoring are also provided by the OECD (van Welsum and Vickery 2005; van Welsum and Reif 2006b). These estimates are more cautious since they do not calculate the actual number of jobs affected by offshoring, but the share of total employment that could potentially be affected by ICT-enabled offshoring. For the year 2003, the OECD finds that up to about 20% of total employment in the OECD could be potentially affected by ICT-enabled services offshoring. The difference between the US (18.1%) and Europe (EU15; 19.2%) is small.

Van Welsum and Reif have also delivered estimations of offshoring at the industry level. The following figure shows the level of employment affected by offshoring in various European industries (see also Appendix Table 5). Computer and related activities (NACE 72) has the highest share of occupations potentially affected with nearly 80%, followed by the financial sector (NACE 65, 66 and 67), the manufacturers of office equipment and computer (NACE 30) and some business services such as commercial R&D (NACE 73) or accounting, legal and advertising services (NACE 74).

These figures are impressive; readers, however, should note that being affected by offshoring always has two faces: on the one hand, it implies job losses; on the other hand, it also includes the chance that incoming services offshoring can be attracted. The financial services sector is an example where Europe already exhibits competitive advantage in international trade which becomes manifest in a considerable trade surplus, in particular due to the UK financial services industry (European Commission 2005, p. 80). Increases in the propensity to offshore in this sector may therefore translate into overall gains, not losses for employment in Europe. However the rigidities of the European labour markets could result into job losses (see Chapter 4 - Policy issue *3. Harmonising and flexibilising labour markets).*

Industries that are very little vulnerable to *services* offshoring encompass all personal services such as education, tourism, health and social work, but also transport and some low- and medium-tech manufacturing industries such as mining, construction, wood, pulp and paper, or textiles. An interesting co-incidence is the fact that these industries are also most reluctant to technological innovation in the service sector (Miles 2005).

Figure 2 Share of employment potentially affected by offshoring in Europe, by industry, 2003



Van Welsum and Reif (2006a, p. 30)

Another interesting result is that the OECD projections assume a divergent direction in the offshoring potential of the US and Europe over time with a decreasing share in the US and an increasing share in Europe. Van Welsum and Vickery (2005) interpret the decline as a sign that *actual* offshoring proceeds at a faster pace in the US than in Europe and therefore reduces *potential* offshoring. They relate this difference to two developments: first, the decreasing potential is a result of the faster adoption of ICTs in the US, which enables offshoring and may speed up the process. Second, they suspect that European firms tend to offshore within Europe to a considerable degree, which may lead to a slower pace of offshoring at the aggregate European level compared to the US.

OECD estimates of an offshoring potential of around 20% of total employment have been confirmed by the work of Blinder (2005) for 2004. Other estimations of potential offshoring vary considerably from the OECD figures. Lower estimates are delivered by Bardhan and Kroll (2003) who come to the conclusion that 11% of total employment in the US was potentially affected by offshoring for 2001. Jensen and Kletzer (2005), in contrast, estimate a share of 30% of employment potentially affected by offshoring in the US.

These considerable variations between different estimations have raised substantial criticism (Bhagwati et al. 2004; Amiti and Wei 2005; Mankiw and Swagel 2006). A first point is that all estimations rest on quite strong assumptions regarding the vulnerability of different occupations to offshoring which also explain the vast variations in the share of employment affected; as Bednarzik (2005) points out, no one has been able to pinpoint precisely how many white-collar jobs in the US have moved overseas so far.

A second point of critique is that these estimates only relate to job losses, but do not take into consideration the number of jobs which the US economy gains from offshoring. As discussed in the preceding section, offshoring does not necessarily lead to job losses at the parent firm, but can also create jobs because of a higher demand for high-skilled services, productivity gains and lower prices for intermediate demand. Such effects have not been taken into consideration in the presented studies.

Finally, Amiti and Wei (2005) or Mankiew and Swagel (2006) argue that some of these studies do not deliver a correct picture of the magnitude of offshoring because they do not relate the potential job losses to the total number of jobs created and destroyed in the US economy each year. Employment fluctuations caused by the business cycle are by far larger than those caused by offshoring.

In this perspective, the estimated job losses seem to be very moderate. Bhagwati et al. (2004) for example argues that the estimation delivered by Forrester Research of 3.4 Mio jobs offshored by 2015 amounts to only about one percent of the annual number of jobs destroyed and created in the US economy. Although the estimated numbers are significant in absolute terms, losses from offshoring are only modest compared to overall job turnover in the US.

Key findings:

- No one has been able to pinpoint precisely how many US or EU white-collar jobs have moved overseas so far.
- The absolute magnitude of offshoring is modest compared to total employment and overall job turnover, but growing.
- Trade data suggest that Europe at large is rather a winner than a loser of services offshoring. In most areas it has maintained its position.
- A broader picture, however, shows that there are winners and losers from services offshoring. In fact, there are differences within Europe in terms of the economic benefits that can be derived from offshoring of IT services, especially between the EU 15 and the EU 10 countries.
- The scope of economic activities and occupations that could potentially be affected by offshoring is significant; estimates say that up to 20% of total employment could be affected. Net effects are expected to be significantly lower though.

2.2 DRIVERS AND MOTIVATIONS FOR OFFSHORING

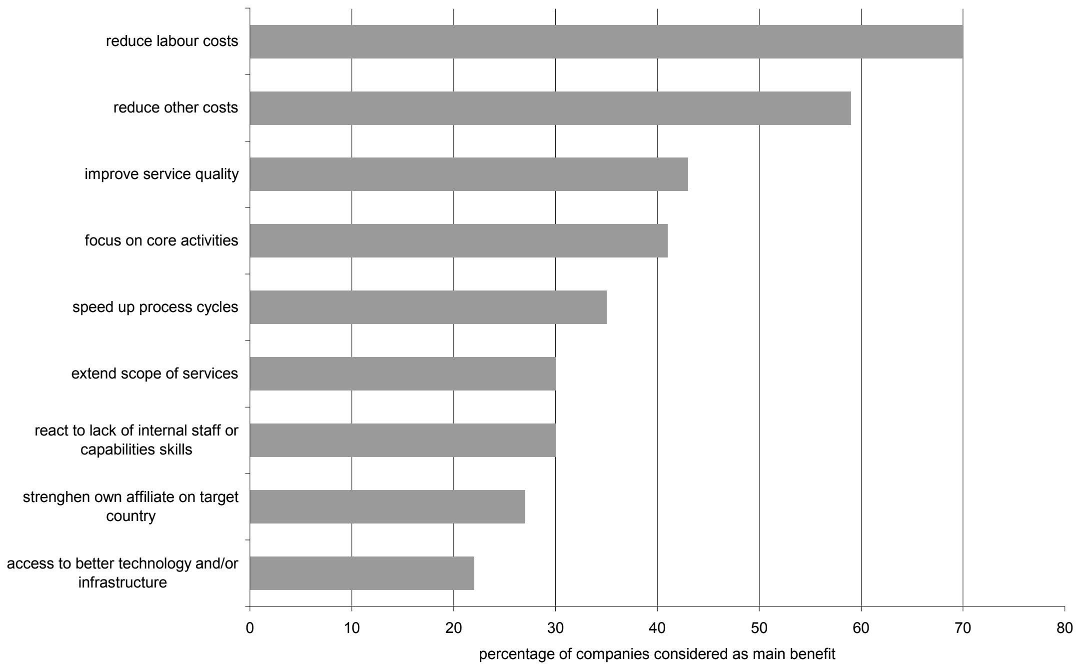
In order to find appropriate policy answers to the challenge of services offshoring, it is important to know the drivers of the process and the underlying motives of enterprises. Offshoring is to a considerable part fuelled by cost advantages, but cannot be explained by costs alone. It also determined by non-cost factors, as shown below.

A study conducted by UNCTAD and Roland Berger (2004) among Europe's Top 500 companies reveals that 70% of the interviewees expect lower wage cost and another 60% reductions in other cost as the main benefits from services offshoring (Figure 1). 43% of the respondents, however, expect improvements in the quality, while another 41% regard offshoring as a means for corporate restructuring and focussing on core activities.

These results show that motives for and potential benefits from offshoring are more complex than the one-dimensional perspective on cost advantages alone. Cost advantages are the most important driver of offshoring, but are rarely the only determinant; in most cases, cost advantages appear in combination with other reasons like market opening, improved flexibility to supply important customers, proximity to key markets.

Offshoring therefore has to be seen in a larger context of corporate restructuring and the internationalisation strategies of enterprises. Explanations that only refer to cost differentials therefore fall short of understanding the process and, in particular, conceal the dynamic aspects with respect to quality and flexibility (Markusen and Maskus 2001; Lipsey 2002; Markusen 2002; Barba Navaretti and Venables 2004). The internationalisation of production is not just a simple 'reducing at home and building up elsewhere', but involves rather complex substitution and complementary effects, determined by different factor cost, factor endowments, market expectations and technological competencies.

Figure 3 Expected main benefits from services offshoring, 2004



Source: UNCTAD and Roland Berger (2004)

The success of offshoring is also determined by some preconditions regarding transferability, task definition and mutual understanding between the outsourcing and the receiving enterprise. These preconditions will be discussed in detail below since they also determine the extent to which services can be offshored; as an example Huws and Flecker (2004), stress four particular prerequisites for successful remote working practices:

- a clearly defined, explicit and standardised working procedures and quality control mechanisms
- good and clear communication patterns between offshoring and receiving firm
- mutual cultural understanding and adjustment
- regular face-to-face meetings.

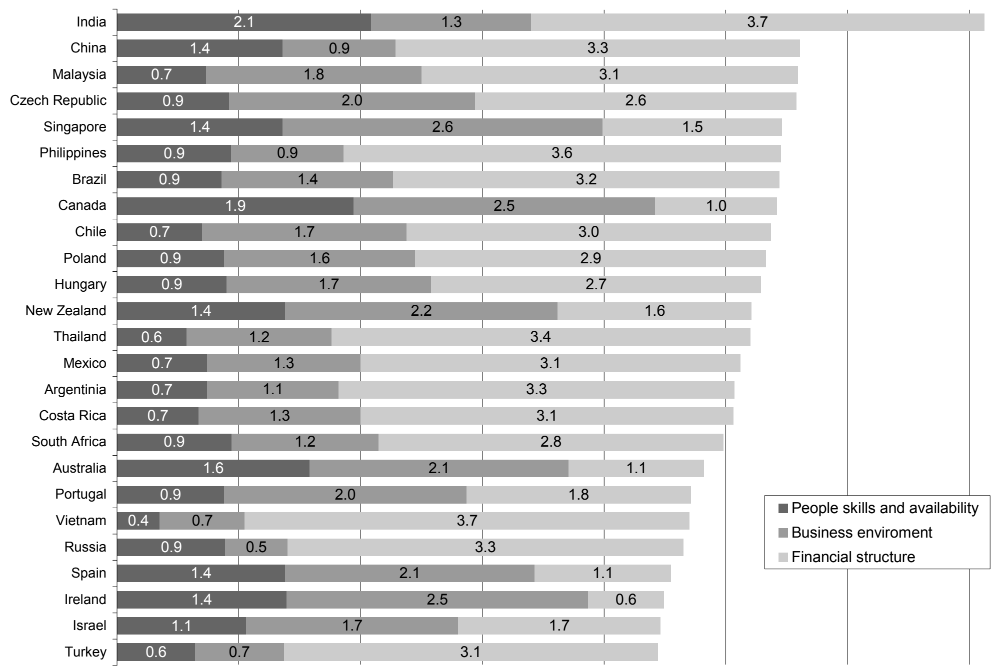
Moreover, the success chances of offshoring depend on a range of location-related factors that are sometimes difficult to capture. As a first approximation, the three categories used to construct A.T. Kearney's Offshoring Location Index (Figure 4) may serve this purpose: *people skills and availability* (business experience, labour force availability, education and language), *business environment* (which includes infrastructure, cultural adaptability and economic and political aspects), and *financial structure* (taxes and costs).

This index also illustrates our claim that offshoring cannot be explained by cost advantages alone and the relative attractiveness of countries for hosting offshoring rests on different pillars. Singapore, Canada or New Zealand, for example, have only little to offer in terms of low wages; they are nevertheless countries able to attract offshoring because they offer favourable business conditions and a highly skilled workforce that compensates for higher wage rates with higher productivity and increased flexibility.

Figure 4 also illustrates the specific advantages of European countries over Asia or South America. India, China and other South-East Asian locations offer very favourable conditions with regard to people skills and availability. Van Welsum and Xu (2007) analyze these advantages in detail for China and compare them with India and other countries. They find a high potential, but still some shortcomings of China compared to India in terms of language skills, the quality of graduates and infrastructure. Despite a large number of graduates, Van Welsum and Xu find that only a small fraction of them is suitable to work in globally engaged activities in IT-enabled services.

The advantages of the Czech Republic, Poland or Hungary also relate to wages and skills. Moreover, these countries also offer a more favourable business environment than China, India, or other locations according to A.T. Kearney. This compensates disadvantages in skills and personnel availability and cost. Advantages in the business environment include the legal system, protection of IPRs, political stability, a favourable infrastructure and cultural adaptability. These non-cost advantages are even larger in the case of Ireland, Portugal and Spain. Non-cost advantages may turn out to be more sustainable than attractiveness solely based on cost, if the countries follow the example of Ireland and manage a constant upgrade of their location-related advantages (Barry 2004; Barry and van Egeraat 2005).

Figure 4 Attractiveness of Various Offshoring Locations, 2004



Numbers are index numbers; financial structure is weighted on a scale of 1 to 4, business environment and people skills on a scale of 1 to 3.

Source: AT Kearney (2004)

We can draw the conclusion from A.T. Kearney's analysis that Europe, and in particular Central and Eastern European countries (CEEC), are attractive offshoring locations. There is reason to believe that Europe will also benefit from offshoring, either by attracting offshoring from outside of Europe, or by exporting services to the 'old' member states of the EU.

The CEECs are attractive locations for Western European offshoring in particular. This attractiveness, however, is not exclusively based on cost advantages. Those countries are part of the single market and therefore share the same business environment. Poland, Hungary or the Baltic states are within one-day travel distance and have a higher degree of cultural proximity with the home countries than Asian locations, an important prerequisite for offshoring (see above). A lack of relevant cultural proximity which also includes corporate culture skills is also discussed by Van Welsum and Xu (2007) for the case of China.

SMEs which may want to avoid the risks and barriers associated with offshoring services to Asia, can benefit from the opportunities offered by these geographically and culturally favourable countries in particular,.

Different offshoring motives also make clear that Europe as a whole will not be able to retain and redirect all offshoring to Central and Eastern European member states. Market access and proximity to clients and competitors are main motives to go abroad with production activities (Dachs et al. 2006). Therefore, it seems unavoidable that a considerable part of offshoring will also move to Asia in the future, given that these countries will sustain economic growth in the future.

Key findings:

- Offshoring is not only motivated by cost advantages, but also by market expansion, increased flexibility and the need to be closer to key clients and competitors.
- Advantages of European locations are not only cost-based but also caused by the business environment and cultural proximity.
- For offshoring to be successful, several pre-conditions need to be met, for instance in terms of knowledge exchange between home and host country, organisation, and the management of cultural differences.
- Central and Eastern Europe has specific advantages to offer for offshoring of IT services, not the least with respect to the aforementioned pre-conditions for successful offshoring. For these reasons, the CEEC are particularly interesting locations for offshoring by SMEs due to the much lower cultural barriers as compared to Asian destinations.
- However, the experiences gained over the past few years with offshoring have given rise to a learning process on how to assess realistically the promises and risks of offshoring and to deal with critical success factors.

3. OFFSHORING AND THE HOME COUNTRIES

3.1 EFFECTS OF OFFSHORING ON THE HOME COUNTRIES

A main concern with respect to offshoring is its impact on the home countries. Public interest in these 'home country effects' of foreign investment goes back to the 1930s (Lipsey 2002, p. 7), but has reappeared in recent years in the course of globalisation debates.

There are two positions on the home country effects of offshoring. On the one hand, critics of globalisation fear that foreign investment and rising imports of intermediate goods and services may substitute production, exports and therefore employment at home. Supporters of globalisation, on the other hand, argue that each economy will benefit from globalisation and offshoring in the long run due to increased specialisation. Each side can present numerous examples to support their point of view.

Why is it so difficult to compare employment and other enterprises variables before and after offshoring and get a clear picture of the effects? The reason lies in the dynamic characteristics of offshoring and the variety of motives involved. In most cases, offshoring is not just a simple 'reducing at home and building up elsewhere'. Motives of market expansion and gaining new customers are intertwined with cutting costs and increasing flexibility by setting up a new production facility.

The current consensus from empirical studies is that there exists no *general* tendency of offshoring substituting domestic jobs by foreign employment at the firm level in the long run (Brainard and Riker 1997; Braconier and Ekholm 2000; Bruno and Falzoni 2003; Crinò 2007). Two econometric studies have also confirmed these results for service offshoring (Amiti and Wei 2006; Crinò 2006).

The outsourcing firm may reduce employment in the short run; in the long run, however, substitution and complementing effects take place which are determined by different factor cost and factor endowments, market expectations and technological competencies of the various production locations. These effects increase the productivity of the parent firm and may even strengthen domestic production. If the firm achieves higher overall sales and a higher overall productivity via foreign activities in the long run, it will also generate additional demand for the output of the stages of production located at home. Services jobs created abroad therefore also stimulate demand for goods and services produced in the home country. Such an effect may be reinforced by lower prices of re-imported services which allow the parent enterprise to further increase production.

Similar effects can also be expected at the aggregate level; it is very unlikely that fast-growing developing countries like India or China will cover their rising demand for intermediate and final products and services entirely by domestic sources. Rather, we can expect that the demand for European goods and services from these countries will increase considerably in the future, just like Germany or Scandinavia became not only competitors, but also important markets for the UK industry at the end of the 19th century (Freeman and Soete 1997).

International outsourcing also affects the skills composition of firms. It shifts relative employment in the home country significantly in favour of high-skilled labour, such as research and development, design, marketing or other headquarter functions (Egger and Egger 2003; Hansson 2005; Castellani et al. 2006; Egger and Egger 2006). In other words, unskilled labour is affected to a higher degree by offshoring than skilled labour. The wage gap between the two groups grows as a consequence of offshoring (Driffield and Taylor 2000). Units in the home country will specialize on more skill-intensive and capital-intensive activities such as highly automated production or flexible, 'customized' manufacturing, while foreign activities exploit factor price advantages of their host countries in labour-intensive production activities.

The dynamic adjustment effects of offshoring are reinforced by self-selection in the internationalisation strategies of firms (Head and Ries 2003; Helpman 2006). Only the most productive firms expand their operations via FDI, while less productive firms choose to export or serve only domestic markets. Foreign production and growth at home goes hand in hand, as Pfaffermayr (2004) shows. Relocation can be regarded as part of a wider growth and diversification strategy to serve foreign markets by local production, and foreign activity may preserve and even reinforce a firm's growth potential at its domestic location.

Here, it is necessary to stress that economic theory and empirical studies deal with average effects of offshoring; they do not state that *everybody* is better off with offshoring and an intensified international division of labour. There are of course, winners and losers of the process; what can be said, however, is that economies in total are better off if they exchange goods rather than produce self-sufficiently.

The findings on the effects of offshoring on the home countries support our conclusion from the previous section that Europe at large should be regarded as a potential winner from offshoring; chances for Europe to attract offshoring in the future look promising, and offshoring can also be, at least at aggregate level, beneficial for the home country in terms of employment and productivity.

An increasing level of offshoring, however, will also require changes in skills profiles in ICT industries. Generally speaking, offshoring will lead to a growing demand for more sophisticated skills levels in Europe. There is clear evidence that low-skilled jobs will be substituted by high-skill occupations due to offshoring. Offshoring therefore requires more high skills, more flexibility and life-long learning in the home country (Mahroum et al. 2005, 2007), and Europe can only reap the benefits from offshoring if appropriate skills are available. Rising levels of offshoring also call for an active labour market policy that helps to bring people who lost their job due to offshoring back into the labour market.

Key findings:

- It is difficult to get a definite judgement on the effects of offshoring on the home countries because offshoring is not just about relocating activities, but is often part of a wider enterprise strategy which involves market opening, changes in specialisation and overall growth of the firm.
- Most empirical studies find no association between offshoring and job growth at the home country in the long run.
- There is a clear need for a skills upgrading in the home country due to offshoring. If this is not assured, the potential benefits of offshoring can hardly be reaped. This, indeed, is a critical issue for many European locations.

3.2 Offshoring – New Trends and Developments

The “second unbundling” revisited

A different way to think about offshoring of services is currently emerging. This view regards offshoring as a disruptive historical process with consequences for developed economies which can be compared to those of the industrial revolution (Blinder 2005; Baldwin 2006; Blinder 2006; Grossman and Rossi-Hansberg 2006a, 2006b). Baldwin (2006) or Pérez (2006), for example, compare the current situation with the rapid fall of transportation costs in the late 19th century which allowed to separate production from consumption in manufacturing at a large scale for the first time. We can relate this second unbundling with even larger, economy-wide transformations described by Pérez (2002; 2006) as the emergence of a new techno-economic paradigm. Pérez identifies globalisation as a main feature of new paradigm which emerges since the 1970s.

The main point brought forward by all these authors with respect to offshoring is that ICTs have radically changed the tradability of services, but also the means to exchange their results and to co-ordinate different tasks over distance. As a consequence, competition no longer takes place at the level of firms or industries, but at the level of single tasks in different nations. In the words of Baldwin (2006, p. 8), this “second unbundling” will bring global competition directly into factories and offices.

While nobody questions that offshoring of services is a fast-growing phenomenon, there are nevertheless doubts about the distributive character of the present process. Baldwin and others argue that the increased tradability will boost offshoring. They may, however, underestimate the increased co-ordination and transaction cost associated with a higher degree of tasks offshoring. Transaction cost theory shows that there are substantial benefits from integration and internalisation. These benefits are related to the problem of incomplete contracts, which arises because contracts cannot take all possible problems between buyer and seller into consideration. Internalisation is a means to overcome this problem.

One could assume from this point of view that an organisational form that just bundles different tasks by different external providers would not be the dominant form of organisation in economic life even if transmission cost were zero because of incomplete contracts and the advantages of firm organisation in terms of supervision and control. Firms that choose offshoring must have a high degree of trust in their offshoring partners to substitute for the loss of control. Moreover, firms are not only a bundle of resources which can be coupled at will, but places of organisational learning and carriers of organisational capabilities that are more than the sum of all their parts.

Some authors may also overestimate the potential of service offshoring because they underestimate the potential of service automation and process innovation in services. Offshoring and automation strategies are substitutive to a certain extent, because both include a considerable cost-cutting potential. Service industries such as finance or wholesale trade successfully applied ICT to rationalize back office processes such as accounting, tracking goods, taking inventories etc. ICT-based automation has turned out to be a very successful strategy to increase productivity in these scale-intensive service sectors (Hipp 2000).

Flecker (2004, p. 18) illustrates this relationship in a case study of an airline which offshored the typing of boarding passes to India in the Mid 1990s. Five years later, the offshored service was relocated back to Europe, because new image recognition technologies now allowed to scan and record the boarding pass information automatically with only very little labour input. The task was finally located at a subsidiary of the company which provides the scanning service in a Central and Eastern European country.

In the light of these additional perspectives, the unbundling argument, while being plausible in general terms, should be re-assessed in terms of its net impacts on offshoring. The focus of attention is shifted to the joint factors facilitating and inhibiting offshoring, and to the role of innovation for counteracting offshoring. However, it should also be clear that innovation and service automation can have similar negative employment effects on the home country as offshoring, but in contrast to offshoring value creation is kept in Europe.

What kind of occupations and services can be offshored?

Before we sketch possible scenarios for the future of offshoring, we return to the discussion on what occupations may be subject to an intensified competition in the future. There are already a number of empirical studies dealing with estimations of the scope of potential or actual offshoring that also include lists of features of offshorable tasks (see Box 1). We will summarize these features in four dimensions that are crucial in determining the likelihood of a service to be offshored:

Form of delivery

An important feature of services is the mode of delivery. Miles (1996) distinguishes between physical services which involve manipulation on things, person-centred services and information services.

The mode of delivery is also an important determinant to identify potentially offshorable services. According to Blinder (2005) and others, personally-delivered services where service supplier and customer have to be at the same location are only hardly offshoreable.

This excludes a number of physical and person-centred services from offshoring which involve a treatment of things owned by a buyer or the buyer him or herself, such as health, maintenance, transport or tourism services. This group of services is “personal” for a variety of reasons. Some literally require face-to-face contact (e.g. child care workers). Others are inherently “high-touch” (e.g., nurses) or involve high levels of personal trust (e.g. psychotherapists). Others benefit from location-specific attributes that are not easily to replicate elsewhere (Washington lobbyists need attendance in the capital).

Delivery is an important constraint to offshoring; it is, however, conceivable that new forms of self-service based on ICT substitute physical or person-centred services. Self-service has been a powerful trajectory in service innovation (Miles 2005). An example with respect to offshoring would be ICT-mediated consultation of a doctor in combination with diagnostic equipment that allows remote monitoring the patient. ICT-based expert systems and easy-to-handle tools could provide clients with the necessary information to deliver various tasks by themselves.

Degree of codification

Codification means that it must be possible to bring all things necessary to perform the task as well as the results of the task into electronic form. The problem with codification is that it is easy to codify information, but difficult to codify knowledge (Cohendet and Steinmueller 2000; Cowan et al. 2000; Foray 2004).

Dominique Foray presents a nice example for the difference between knowledge and information (2004, p. 4): information "takes the shape of structured and formatted data", such as scientific publications, weather forecasts or stock prices. Information can be reproduced at very low marginal cost (although its production may be costly). The main economic problem of information is its protection and disclosure, because information has some public good characteristics (Foray 2004, p. 5).

Knowledge, in contrast to information, "empowers its possessors with the capacity for intellectual or physical action" (Foray 2004, p. 4). Knowledge is therefore needed to put information into action; it is not structured and formatted data, but enables us to interpret this data. Moreover, knowledge is context-specific and often produced for a local context and for a specific purpose (Cowan et al. 2000; Breschi and Lissoni 2001). Stock prices, for example, are pieces of information readers can pick from every newspaper. However, it requires specific knowledge to make sense of it and recognize if a certain stock is undervalued or not. Without this knowledge, the economic benefit one derives from information on stock prices will be very limited.

If the service provider just needs information that can be codified to fulfil his task, offshoring is possible. If the service provider has to rely on specific knowledge only available at the buyer's location, offshoring becomes increasingly costly and difficult. This could be, for example, knowledge of how bank employees use information systems in contact with customers. In such cases, at least a small presence of the service provider at the customer's location is necessary to translate and mediate between customer and the distant service provider.

Box 1: What are characteristics of offshoreable tasks? A short survey of the literature

Several studies have extracted key characteristics of services that favour or disfavour their offshoring. The subsequent examples may serve as an illustration that they tend to point out the same key features.

Bardhan and Kroll (2003, p. 4)

- No face-to-face servicing requirement;
- High information content;
- The work process is telecommutable and Internet-enabled;
- High wage differentials with similar occupations in destination country;
- Low set-up barriers; and
- Low social networking requirements.

Garner (2004, p. 17)

- Labour intensive – wage differentials between countries
- Information-based, output can be delivered electronically
- Codifiable – needs not tacit knowledge component
- High-transparency – task and progress can be easily measured and controlled

Huws and Flecker (2004)

- Clearly defined, explicit and standardised working procedures and quality control mechanisms
- Good and clear communication patterns between offshoring and receiving firm
- Mutual cultural understanding and adjustment
- Regular face-to-face meetings.

Huws, Dahlmann and Flecker (2004, p. 5)

- Jobs designed so that tasks requiring face-to-face contact are separated from those which can be carried out remotely
- The work to be transferred does not depend on tacit knowledge
- Tasks are clearly defined and standardised with performance measures enabling effective monitoring of results
- Well-defined work procedures and quality control mechanisms are in place
- Good clear communication patterns exist
- Mutual cultural understanding and adjustment has been established
- A relationship of trust has been established
- Opportunities exist for face-to-face contact for conflict resolution and to ensure effective management and training.

Van Welsum and Vickery (2005, p. 12)

- People exercising jobs where they make intensive use of ICTs
- Their output can be traded/transmitted with the help of ICTs
- The work has a high explicit information or “codified knowledge” content (and no or little tacit or implicit knowledge).
- The work does not necessarily require face-to-face contact.

Co-ordination requirements

Co-ordination relates to the fact that a number of services require exchange between the seller and the buyer. This may be because the tasks have not (or could not) been defined properly at the beginning of the process like in many customer-centred innovation processes where the propensities of the final outcome are a result of the process. A high level of co-ordination is also necessary when services are delivered in mixed teams jointly with the client.

Co-ordination becomes important when the goals, methods and expected outcomes of the project have not or could not been defined clearly at the beginning of the project. It is easier when both parties have worked together in the past, because co-operation helps to build up a common tacit knowledge and a common terminology. Co-ordination is also associated with control and trust. If the service delivery can be co-ordinated over the phone, includes only little tacit knowledge and all parties are already experienced in working together, co-ordination needs should not hamper offshoring.

Cost differentials

Differences in the cost of service production between the buyer's and the seller's country are the most obvious reason for offshoring. It should, however, be noticed that differences in wages do not sufficiently describe the total cost differentials in offshoring. Separating parts of the production chain and locating them in different countries causes also additional transaction costs, such as co-ordination, supervision and contract enforcement, not to speak of the risk of leakage of knowledge to local competitors. Moreover, wage differentials also reflect productivity differentials to a considerable degree.

Language factor

With regard to language aspects for call centres in particular, one should make a distinction between languages used across various countries (English, French, Spanish and Portuguese) and other languages. Language-bound outsourcing will affect countries like France (e.g. with North Africa) or the UK (e.g. Commonwealth countries) much more than, say, Greece, Denmark or Germany, as the need for translation in the latter would enhance the transaction costs significantly. One of the emerging trends is for call centres to implement VoIP-based platforms which enable on the one hand to reduce costs while VoIP systems may on the other hand offer the potential for language translation services. As a universal translator may not be within reach nor is it likely to be necessary, natural language processing and speech recognition could be combined to offer on-the-fly translation between two to five languages simultaneously.

Scenario sketches

We will now develop three scenario sketches that incorporate the discussion above and draw possible futures of service offshoring. The first scenario corresponds to the vision of the "great unbundling" as a disruptive process of historical magnitude as brought forward by Baldwin and others. The volume of offshored services will increase considerably. Europe, however, will also develop into an attractive location for inward offshoring.

The second scenario also assumes an increase in the outgoing volume in service offshoring; the volume of inward offshoring, however, will remain well below expected volumes and

European service provider did not manage to compete with Asia, North America or South America.

In a third scenario, we describe a situation where the volume of both, incoming and outgoing offshoring, remained considerably lower than in the two preceding scenarios. Here, a number of factors that hamper offshoring prevent a development as described by Baldwin and others.

Scenario 1 "Jobs losses, jobs gains"

The fragmentation of production chains involving services has increased considerably because services offshoring was facilitated by present and new information and communication technologies. Enterprises regarded service offshoring as a mean to cut cost, but also as part of their internationalisation strategies.

The magnitude of this development reached a size of up to 10% of total employment in both manufacturing and services sectors. As a result, employment in many service occupations, in particular in low skills-occupations, eroded. Sectors hit hardest were financial services, computer services, wholesale but also some capital intensive manufacturing sectors. This was partly due to rigidities at the European labour markets which could not provide employment in other parts of the economy, partly to a lack of skills and life-long learning.

However, service jobs were also created, in particular in occupations that require high-skilled professionals. European service providers were successfully competing with Extra-EU enterprises in business services, such as financial services, consulting, etc. As a result, there was a massive structural change in these sectors towards high value-added services. This development was only possible in parallel with a massive skills upgrading and restructuring of the qualification profiles of workforce.

Europe faced massive increases in service imports from extra-EU countries, but also massive increases in service exports to these countries. To a larger part, however, offshoring of services happened within the EU27, and this is why Europe at large faced a lower volume of outgoing service offshoring than the US.

The New Member States were partly winners of the development, partly because they benefited from the new demand from the old member states, partly because they had higher internal growth rates in demand for business services. Moreover, some countries like Esonia or Bulgaria itself developed into successful competitors on the international market for business services.

Scenario 2 "My job went to Mongolia"

There was indeed a service revolution and a boost in the share of services provided by Third parties. However, analysts underestimated the potential losses and overestimated the potential gains. Europe has benefited from a boosting demand for sophisticated business services in consulting, accounting, advertising, financing from Extra-EU economies. Some locations in Eastern Europe developed into major providers of business services and managed to catch a bulk of the new demand for services from the old member states. In total, however, Europe was a looser of the service offshoring revolution.

Looking back, the main weakness of Europe was its inability to reallocate and retrain people so they could be brought back into the labour market. Europe was increasingly facing a skills mismatch in services occupations with a surplus of low-skilled service workers and shortages of highly trained professionals.

The demand for highly skilled personnel grew faster than Europe's universities could train young people, which was also due to unfavourable demographics compared to the US which has a larger share of younger people on the population. As a result, Europe could not take advantage of the booming international market for high-skilled services offshoring.

Europe was under pressure from two sides: First, it did not succeed in competing with US, Canadian, Australian but also some Indian companies in the sophisticated segments of the offshoring market. Second, Europe faced pressure in bulk services offshoring because new offshoring locations have emerged which successfully competed with the 'old' offshoring locations India and China. New countries in Asia entered the global offshoring market, and also African and South American countries increasingly took advantage of the skills of their population and provided French-, English- and Spanish-language call centre services.

The old EU members have been affected most severely by the development. Only few specialized business services managed to benefit from the trend in these countries, but could not compensate job losses. Hopes that losses at domestic markets for business services would be outweighed by higher exports to Asia and the US also turned out to be wrong for a second reason; increased demand of Asian countries for business services was satisfied by domestic service providers in these countries to the largest degree. Moreover, European business services did not succeed in competing with US companies at Asian markets, which have successfully specialised in the most sophisticated and skill-intensive segments of the market are now the leading providers of these services. The CEEC were in a better competitive position due to their lower labour costs, but were similarly affected a shortage of skilled labour.

Europe would have been able to benefit to a larger degree from offshoring if it invested more in education and training, in particular in life-long learning and in strengthening the ability to move from one occupation and location in Europe to another. As part of such a package, a major reform of labour markets would have been necessary, including further steps towards the realisation of a single European labour market.

Scenario 3 "After the Goldrush"

ICT-enabled offshoring of services indeed increased in recent years; however, the development proceeded at a much slower pace than many observers have forecasted. Analysts largely overstated the opportunities of offshoring, after a huge boom many enterprises envisaged the limits of offshoring and relocated services back to the home country which caused the "Outsourcing bubble" to burst in the late 2000s. This could be accounted to the following factors:

Advances in ICT, in particular image and voice recognition, artificial intelligence and visualisation allowed performing many tasks without any human involvement. As a consequence, it was not reasonable anymore to offshore, and many services were insourced and performed in-house again, but with considerably less personnel.

In many cases offshoring of services turned out to be more complicated than the offshoring of manufacturing processes. This was partly due to the difficulties to standardize and describe properly. But it was also a problem of tacit knowledge and the ability to transfer such tacit knowledge necessary for service provision. One particular hampering factor was cultural difference. It turned out that many potential offshorable services, such as programming and designing needed at least some understanding of the context in which it would be used.

As a result, many service offshoring projects failed or could only be carried out at considerably higher cost than foreseen. Enterprises were disappointed by the quality and productivity.

Moreover, security aspects became more important to companies. Many enterprises preferred to perform critical business processes such as accounting, marketing, research and development or design in-house, even if the costs were higher. Aspects of availability, closeness and control seemed to dominate cost and flexibility aspects.

Another factor which prevented a strong increase in service offshoring was economic prosperity in offshoring locations. Service industries in India, China, and other offshoring locations were facing strong wage increases, in particular for people with the skills to take over sophisticated service offshoring jobs. This was partly due to rising levels of incoming offshoring activity, but also due to a strong demand for skilled personnel from the domestic economy. Emigration of skilled personnel from Asia to Europe and the US[191] further stressed the labour markets in these countries. As a result, the wage gap was reduced and offshoring became far less attractive.

Offshoring of services was further slowed down by active labour market policy, more labour market flexibility and decreasing non-wage labour cost as a reaction to unemployment in low-skill occupations. These measures were accompanied by massive promotion of training and life-long learning.

From a theoretical point of view, it should be noted that a fourth scenario could be envisaged according to which outsourcing remains weak but "insourcing" becomes very strong. However, as this scenario is very unlikely to materialise it has not been developed in this report.

[191] Movement of people can be regarded, to some degree, as a substitute to offshoring

Key findings:

- The debate about the future of offshoring is split. Factors driving further fragmentation and thus potential for outsourcing are – at least partly – outweighed by considerations regarding barriers to offshoring and arguments in favour of local provision of services – as captured in the four key characteristics determining the offshoreability of services: form of delivery, degree of codification, co-ordination requirements, and cost differentials. Overall, it seems unlikely that the impacts of the – in principle unquestioned - fragmentation process will be of the magnitude expected by its main proponents.
- A high level of innovation in services may contribute to a significant shift in the (labour) cost structures of services. Rather than offshoring, service activities may therefore be affected by rationalisation pressure. This may equally lead to job losses, but not to a shift of activities to offshore locations. Innovation works both ways, i.e. to facilitate offshoring, but also to replace offshoreable activities by automated processes
- It appears that a high share of services might be affected by offshoring (up to 80% in some areas), but being "affected" can mean two different things. Some services might be offshored from Europe to other locations, but Europe may equally be the preferred global location for other types of IT services. Offshoring impact thus implies both risks and opportunities for IT service activities in Europe.
- The three scenario sketches may draw different pictures, but in essence the implications and key policy issues are quite similar; they only differ in terms of their magnitude.

4. POLICY CONCLUSIONS

The scenarios may be quite different in terms of the respective impacts on Europe, but the implications they raise for policy are actually quite similar. Two general insights should in any case be kept in mind.

First of all, attention should be paid not only to offshoring of IT services to Asia. Instead, the US will remain Europe's main important competitor and cooperation partner in the area of highly sophisticated and knowledge-intensive IT services. In this area, Europe has a high potential to maintain and should further improve its strong competitive position globally.

Secondly, and related to the first argument, Europe should regard the growing importance of offshoring of certain types of IT services not only as a threat, but rather as an opportunity. It will be decisive both to exploit the opportunities and combat the risks. With these two basic arguments in mind, the following four key conclusions for policy can be highlighted:

1. Open markets, open policy and beyond…

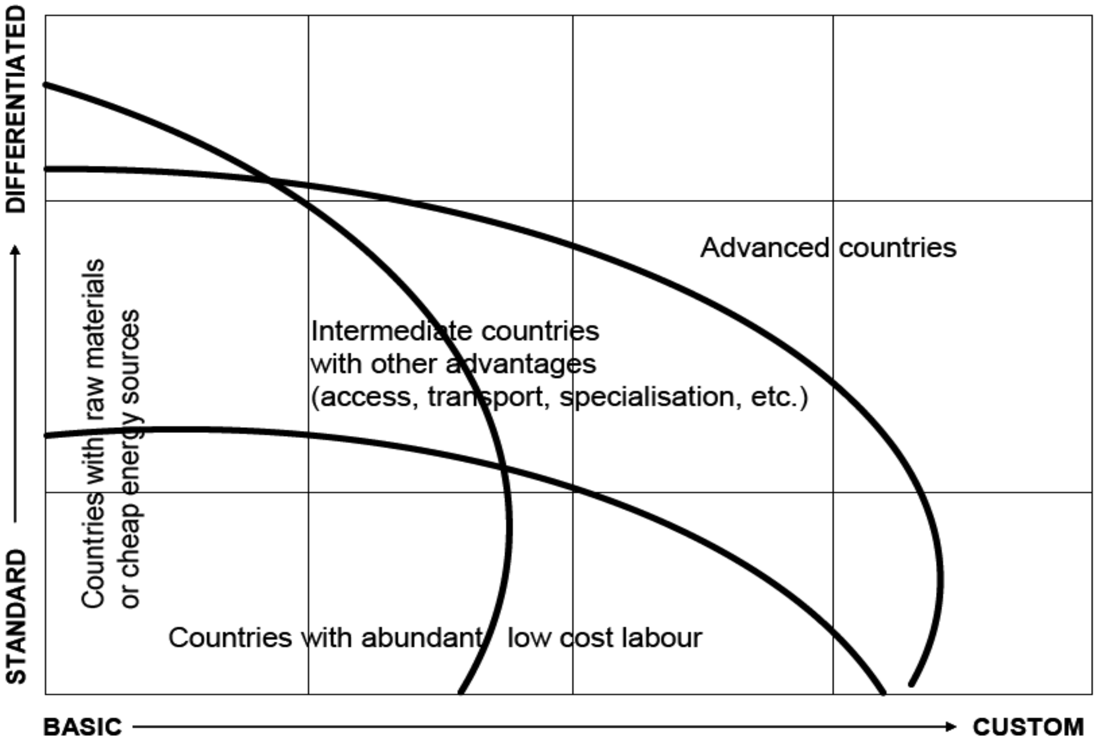
There is nothing which can be won by raising trade barriers and obstacles to the international trade in services. First, because Europe cannot argue against such obstacles if one uses them itself. Second, we see that offshoring also has positive consequences for the home country. Third, a protectionist policy may at best be a short-term remedy.

On the contrary, Europe should try to exploit the opportunities of offshoring. In this sense, the problem is not offshoring to other countries as such, but the ability of Europe to attract service offshoring from abroad. Some countries are already – for different reasons - doing very well (Ireland, UK, Baltic States), while others, in particular Germany, did not success in attracting high levels of foreign investment in IT services.

It is, however, important to consider differences in factor endowments, skills, specialisation etc which will lead to different strategies for European countries as illustrated by Figure 5: Europe should, on the one hand, become a major offshoring destination for highly customized and differentiated services. Trade data presented in section 3 indicate that some European countries, in particular the UK have already reached such a position.

A different position may be suitable for some new member states with advantages in labour cost. Enterprises from these countries may develop into major providers of customized, but more bulk, standard services such as call centres. A necessary component of such a strategy, however, is constant upgrading of skills and location-related advantages as could be learned from the example of Ireland (Barry and van Egeraat 2005).

Figure 5: Possible trends in the global distribution of the hyper-segmented markets of each industry



Source: (Peréz 2006, p. 48)

2. Fostering innovation in IT services in Europe

Strengthening innovation efforts in IT services will be key for counteracting the potential risks associated with the offshoring of IT services. The development and use of innovative technologies in IT services promises to outweigh the labour cost advantages that still represent the strongest argument for offshoring.

Such a strategy requires first of all a dynamic and innovation-friendly environment. This is in itself not a new insight, but it is worth stressing the importance of innovation – and in many instance of research – for strengthening the position of IT services in Europe, especially as it has not been an area of major attention by funding agencies and governments. The creation of sophisticated and demanding home markets for IT services could be an important element of such an innovation-oriented strategy, and an element where governments can exert a strong leveraging function.

3. Harmonisation and flexibilisation of labour markets

There are no doubts that jobs will be affected by the growing importance of offshoring, independently of its magnitude. Even the most successful scenarios in terms of exploiting the opportunities offered by offshoring will have significant implications on the labour force. Policy makers should not ignore that there will be losers in the process although Europe as a whole seems to rather benefit than suffer from offshoring. The key issue in this context is how to help those who lose jobs due to offshoring find new jobs. The OECD employment outlook (OECD 2005b) finds that re-employment rates are considerably lower in Europe than in the

US, which indicates that unemployed in Europe find it more difficult to get back into work following trade-related replacement than in the United States. Making labour markets flexible is one means to facilitate adjustment processes to take place. Another and complementary important building block is the flexibility of workers themselves. Workers must be given the means to adjust to new requirements and job profiles. As Baldwin argues, offshoring moves from the level of industries and skill groups to the level of individual tasks. This implies that policy can not be sure that one particular group of workers with their specifics is more or less affected. Policy should therefore promote individual skill development and here in particular the ability to learn and re-learn new things. This has far-reaching implications for our entire learning and education systems, from early school age to life-long learning. While this lesson may not be new either, its importance is reinforced by the arguments stemming from the "second unbundling" debate.

4. Expansion and upgrading of the skills base

This final conclusion does not come as a surprise, either. It is based on the insight that low-skill jobs in Europe can be replaced by high-skill jobs as a result of offshoring processes only if the necessary skills are available in appropriate quality and quantity. In order to be able to exploit the potential opportunities of the trend towards offshoring, it will first of all be crucial to offer an adequate capacity of highly skilled labour.

For Europe this implies that the expansion of the skilled labour is an important issue. The skilled labour reserve in Europe is still significant, and extends to as diverse social groups as women, elderly and migrants (Mahroum et al. 2004).

The quality of skills needed to ensure that sophisticated IT services and related innovation activities can be performed in Europe are also changing, similarly to those in the IT industries in general. This development goes beyond the usual upskilling argument; the so-called "highly skilled" will also need to adapt to the new requirements resulting from the unpredictable nature of technology and market dynamics in an increasingly globalised and fragmented industrial environment (Mahroum et al. 2007). Hybrid rather than specialist skills, a high degree of flexibility, and the ability and willingness to continuously change personal specialisation and skills profiles are increasingly sought.

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ACRONYMS / GLOSSARY

Acronym/ Term	Description
Bop	Balance of Payments
FDI	Foreign Direct Investment
R&D	Research and Development

ANNEXES

Taxonomies of occupations potentially affected by offshoring according to Van Welsum and Vickery (2005)

Appendix Table 1. Europe: Occupations potentially affected by offshoring

3 Digit ISCO-88
123: Other specialist managers
211: Physicists, chemists, and related professionals
212: Mathematicians, statisticians and related professionals
213: Computing professionals
214: Architects, engineers, and related professionals
241: Business professionals
242: Legal professionals
243: Archivists, librarians, and related information professionals
312: Computer associate professionals
341: Finance and sales associate professionals
342: Business services agents and trade brokers
343: Administrative associate professionals
411: Secretaries and keyboard-operating clerks
412: Numerical clerks
422: Client information clerks

Table A.2. United States: Occupations potentially affected by offshoring

CPS categories			
accountants and auditors	23	Archivists and curators	165
underwriters	24	Economists	166
other financial officers	25	Urban planners	173
management analysts	26	Authors	183
architects	43	Technical writers	184
aerospace engineer	44	Editors and reporters	195
metallurgical and materials engineers	45	Air traffic controllers	227
mining engineers	46	Computer programmers	229
petroleum engineers	47	Tool programmers, numerical control	233
chemical engineers	48	Supervisors and Proprietors, Sales Occupations	243
nuclear engineers	49	Insurance sales occupations	253
civil engineers	53	Real estate sales occupations	254
agricultural engineers	54	Securities and financial services sales occupations	255
Engineers, electrical and electronic	55	Sales occupations, other business services	257
Engineers, industrial	56	Supervisors, computer equipment operators	304
Engineers, mechanical	57	Supervisors, financial records processing	305
marine and naval architects	58	Chief communications operators	306
engineers, n.e.c.	59	Computer operators	308
surveyors and mapping scientists	63	Peripheral equipment operators	309
computer systems analysts and scientists	64	Secretaries	313
operations and systems researchers and analysts	65	Typists	315
Actuaries	66	Transportation ticket and reservation agents	318
Statisticians	67	File clerks	335
Mathematical scientists, n.e.c.	68	Records clerks	336
Physicists and astronomers	69	Bookkeepers, accounting, and auditing clerks	337
Chemists, except biochemists	73	Payroll and timekeeping clerks	338
Atmospheric and space scientists	74	Billing clerks	339
Geologists and geodesists	75	Cost and rate clerks	343
Physical scientists, n.e.c.	76	Billing, posting, and calculating machine operators	344
Agricultural and food scientists	77	Telephone operators	348
Biological and life scientists	78	Bank tellers	383
Forestry and conservation scientists	79	Data-entry keyers	385
Medical scientists	83	Statistical clerks	386
Librarians	164		

Source: OECD, based on US Current Population Survey.

Table A.3. Canada: Occupations potentially affected by offshoring

SOC91 Canada			
A121	Engineering, Science and Architecture Managers	C012	Chemists
A122	Information Systems and Data Processing Managers	C013	Geologists, Geochemists and Geophysicists
A131	Sales, Marketing and Advertising Managers	C014	Meteorologists
A301	Insurance, Real Estate and Financial Brokerage Managers	C015	Other Professional Occupations in Physical Sciences
A302	Banking, Credit and Other Investment Managers	C021	Biologists and Related Scientists
A303	Other Business Services Managers	C031	Civil Engineers
A311	Telecommunication Carriers Managers	C032	Mechanical Engineers
A312	Postal and Courier Services Managers	C033	Electrical and Electronics Engineers
A392	Utilities Managers	C034	Chemical Engineers
B011	Financial Auditors and Accountants	C041	Industrial and Manufacturing Engineers
B012	Financial and Investment Analysts	C042	Metallurgical and Materials Engineers
B013	Securities Agents, Investment Dealers and Traders	C043	Mining Engineers
B014	Other Financial Officers	C044	Geological Engineers
B022	Professional Occupations in Business Services to Management	C045	Petroleum Engineers
B111	Bookkeepers	C046	Aerospace Engineers
B112	Loan Officers	C047	Computer Engineers
B114	Insurance Underwriters	C048	Other Professional Engineers, n.e.c.
B211	Secretaries (except Legal and Medical)	C051	Architects
B212	Legal Secretaries	C052	Landscape Architects
B213	Medical Secretaries	C053	Urban and Land Use Planners
B214	Court Recorders and Medical Transcriptionists	C054	Land Surveyors
B311	Administrative Officers	C061	Mathematicians, Statisticians and Actuaries
B312	Executive Assistants	C062	Computer Systems Analysts
B412	Supervisors, Finance and Insurance Clerks	C063	Computer Programmers
B512	Typists and Word Processing Operators	C152	Industrial Designers
B513	Records and File Clerks	C172	Air Traffic Control Occupations
B514	Receptionists and Switchboard Operators	E012	Lawyers and Quebec Notaries
B521	Computer Operators	E031	Natural and Applied Science Policy Researchers, Consultants and Program Officers
B522	Data Entry Clerks	E032	Economists and Economic Policy Researchers and Analysts
B523	Typesetters and Related Occupations	E033	Economic Development Officers and Marketing Researchers and Consultants
B524	Telephone Operators	F011	Librarians
B531	Accounting and Related Clerks	F013	Archivists
B532	Payroll Clerks	F021	Writers
B533	Tellers, Financial Services	F022	Editors
B534	Banking, Insurance and Other Financial Clerks	F023	Journalists
B553	Customer Service, Information and Related Clerks	F025	Translators, Terminologists and Interpreters
B554	Survey Interviewers and Statistical Clerks	G131	Insurance Agents and Brokers
C011	Physicists and Astronomers		

Source: OECD, based on Statistics Canada.

Table A.4. Australia: Occupations potentially affected by offshoring

ASCO 4-digit	
1221 Engineering Managers	2521 Legal Professionals
1224 Information Technology Managers	2522 Economists
1231 Sales and Marketing Managers	2523 Urban and Regional Planners
1291 Policy and Planning Managers	2534 Journalists and Related Professionals
2111 Chemists	2535 Authors and Related Professionals
2112 Geologists and Geophysicists	3211 Branch Accountants and Managers (Financial Institution)
2113 Life Scientists	3212 Financial Dealers and Brokers
2114 Environmental and Agricultural Science Professionals	3213 Financial Investment Advisers
2115 Medical Scientists	3294 Computing Support Technicians
2119 Other Natural and Physical Science Professionals	3392 Customer Service Managers
2121 Architects and Landscape Architects	3399 Other Managing Supervisors (Sales and Service)
2122 Quantity Surveyors	5111 Secretaries and Personal Assistants
2123 Cartographers and Surveyors	5911 Bookkeepers
2124 Civil Engineers	5912 Credit and Loans Officers
2125 Electrical and Electronics Engineers	5991 Advanced Legal and Related Clerks
2126 Mechanical, Production and Plant Engineers	5993 Insurance Agents
2127 Mining and Materials Engineers	5995 Desktop Publishing Operators
2211 Accountants	6121 Keyboard Operators
2212 Auditors	6141 Accounting Clerks
2221 Marketing and Advertising Professionals	6142 Payroll Clerks
2231 Computing Professionals	6143 Bank Workers
2292 Librarians	6144 Insurance Clerks
2293 Mathematicians, Statisticians and Actuaries	6145 Money Market and Statistical Clerks
2294 Business and Organisation Analysts	8113 Switchboard Operators
2299 Other Business and Information Professionals	8294 Telemarketers
2391 Medical Imaging Professionals	

Source: OECD, based on Australian Bureau of Statistics.

Table A5: Share of employment potentially affected by offshoring for Europe, by industry, 2003 and 1995, taken from Van Welsum and Reif (2006a, p. 30)

NACE	Industry	2003 Total Offshoring	2003 Clerical	2003 Non-clerical	1995 Total Offshoring	1995 Clerical	1995 Non-clerical
1	Agriculture, hunting and related service activities	1.8	1.0	0.8	2.5	1.9	0.6
2	Forestry, logging and related activities	4.3	2.1	2.2	6.2	4.3	1.8
5	Fishing; service activities incidental to fishing	2.0	1.2	0.9	2.5	1.7	0.8
10	Mining of coal and lignite; extraction of peat	10.5	2.4	8.1	6.6	3.2	3.4
11	Extraction of crude petroleum and natural gas;	43.5	10.7	32.8	31.5	10.7	20.8
12	Mining of uranium and thorium ores	19.2	11.7	7.5	13.4	6.8	6.6
13	Mining of metal ores	19.1	8.0	11.0	10.7	4.0	6.7
14	Other mining and quarrying	10.5	5.4	5.1	8.1	4.2	3.8
15	Manufacture of food products and beverages	11.6	4.5	7.1	10.9	4.9	6.0
16	Manufacture of tobacco products	22.6	8.4	14.2	15.1	5.7	9.4
17	Manufacture of textiles	13.2	7.0	6.2	11.2	6.6	4.6
18	Manufacture of wearing apparel; dressing and dyeing of fur	9.5	4.8	4.7	5.6	3.0	2.6
19	Tanning and dressing of leather; manufacture of leatherwear	9.5	6.1	3.5	7.8	5.9	1.9
20	Manufacture of wood	7.9	4.0	3.9	6.9	3.8	3.1
21	Manufacture of pulp, paper and paper products	14.7	5.1	9.7	13.6	5.6	8.1
22	Publishing, printing and reproduction of recorded media	23.3	8.8	14.5	21.0	9.9	11.1
23	Manufacture of coke, refined petroleum products and nuclear fuel	35.6	9.3	26.3	33.0	11.4	21.6
24	Manufacture of chemicals and chemical products	31.2	7.9	23.3	26.7	8.7	18.0
25	Manufacture of rubber and plastic products	14.9	6.0	8.9	14.6	5.9	8.7
26	Manufacture of other non-metallic mineral products	14.1	5.6	8.4	11.2	5.7	5.6
27	Manufacture of basic metals	13.7	6.1	7.5	11.6	4.5	7.1
28	Manufacture of fabricated metal products	12.8	5.4	7.4	11.8	6.0	5.7
29	Manufacture of machinery and equipment, n.e.c.	20.6	6.5	14.1	19.2	7.2	12.0
30	Manufacture of office machinery and computers	52.0	7.7	44.3	49.5	9.4	40.1
31	Manufacture of electrical machinery and apparatus, n.e.c.	23.6	6.4	17.2	21.3	6.5	14.7
32	Manufacture of radio, television and communication equipment	32.2	6.2	26.1	27.3	6.8	20.5
33	Manufacture of medical, precision and optical instruments	26.9	7.7	19.3	22.1	6.8	15.3
34	Manufacture of motor vehicles, trailers and semi-trailers	17.1	4.3	12.8	12.7	4.5	8.2
35	Manufacture of other transport equipment	25.2	4.8	20.4	19.0	5.5	13.5
36	Manufacture of furniture; manufacturing n.e.c.	12.1	6.2	6.0	9.7	5.6	4.1
37	Recycling	11.8	6.3	5.4	11.4	6.0	5.4
40	Electricity, gas, steam and hot water supply	32.7	13.6	19.2	26.8	12.2	14.6
41	Collection, purification and distribution of water	28.3	12.4	16.0	24.3	13.0	11.3
45	Construction	9.4	3.8	5.6	9.2	4.2	5.0
50	Sale, maintenance and repair of motor vehicles and motorcycles	15.2	7.0	8.1	13.6	6.6	7.0
51	Wholesale trade and commission trade	38.1	10.1	28.0	35.7	11.0	24.7
52	Retail trade	11.7	3.7	8.0	9.6	3.6	6.0
55	Hotels and restaurants	4.5	3.0	1.5	4.0	2.8	1.2
60	Land transport; transport via pipelines	9.4	4.7	4.7	8.4	4.7	3.7
61	Water transport	19.7	9.8	9.9	13.9	6.9	7.0
62	Air transport	23.8	11.8	11.9	20.5	9.3	11.3
63	Supporting and auxiliary transport activities; activities of travel agencies	25.3	14.8	10.5	23.0	13.3	9.6
64	Post and telecommunications	28.5	12.6	15.9	16.1	9.2	6.9
65	Financial intermediation, except insurance and pension funding	62.1	38.2	24.0	55.4	37.1	18.3
66	Insurance and pension funding, except compulsary social security	71.1	33.8	37.3	73.5	35.2	38.2
67	Activities auxiliary to financial intermediation	67.7	25.1	42.6	74.5	30.5	44.0
70	Real estate activities	44.0	14.9	29.1	43.9	16.3	27.6
71	Renting of machinery and equipment	27.3	12.5	14.7	26.1	11.8	14.4
72	Computer and related activities	79.4	9.0	70.5	73.9	12.8	61.1
73	Research and development	41.1	6.1	35.1	36.3	7.9	28.4
74	Other business activities	47.7	17.3	30.3	49.1	20.3	28.8
75	Public administration and defence; compulsary social security	22.0	14.1	7.9	23.0	16.0	7.0
80	Education	7.6	4.2	3.3	6.3	3.7	2.5
85	Health and social work	7.5	5.6	1.9	8.2	6.3	1.8
90	Sewage and refuse disposal, sanitation and similar activities	9.1	5.2	3.9	8.0	4.2	3.8
91	Activities of membership organisation, n.e.c.	26.5	16.9	9.6	24.7	17.2	7.5
92	Recreational, cultural and sporting activities	15.0	6.5	8.5	14.5	6.4	8.0
93	Other service activities	8.5	5.1	3.4	8.6	5.0	3.6
95	Private households with employed persons	1.6	1.3	0.3	0.8	0.5	0.2
99	Extra-territorial organisations and bodies	30.1	15.8	14.4	28.3	18.2	10.1

Notes. 1. EU15 except Luxembourg in 2003, and EU15 except Finland and Sweden in 1995. The total share for the top ten ranked industries in the total offshoring category in 2003 and 1995 are in shading.

Source: OECD calculations based on EULFS.

Institute for Prospective Technological Studies

EMERGING TREND UPDATE 3
The Role of ICTs as Enabler for Energy Efficiency

EPIS Work Package 1 – Deliverable 1.3 ETU3

Administrative Arrangement
30-CE- 0070769/00-29

EUROPEAN COMMISSION

ETEPS NET European Techno-Economic Policy Support Network

IPTS – IS Unit

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** The ETEPS AISBL – European techno-economic policy support network was set up on the initiative of the IPTS in 2005 by 19 effective members from 15 EU Member States. It further counts 19 associated members worldwide and is supported by a network of external organisations. Its main mission is to provide intellectual services for carrying out techno-economic and policy-related studies in the context of EU policy-making. See www.eteps.net for further information.*

EXECUTIVE SUMMARY

Sustainable development has played an important role in EU policies for some time and energy efficiency has been the focus of a number of EU measures. The i2010 initiative in particular addresses ICTs as a tool for environmental sustainability and a means to achieve better quality of life. In the current context of climate change, ICTs for energy efficiency are posed to play an important role and likely to open up market opportunities, contributing to growth and jobs in Europe.

Although ICTs have the potential to increase energy efficiency in many areas, the focus of this paper is mainly on electricity and energy efficiency, both on the supply and demand sides. For the latter, one should distinguish between **direct effects** (ICT need for electrical energy), **indirect effects** (increased efficiency through e.g. better control) and **systemic effects** (i.e. impact of large scale application of ICT), whereby most studies to date have focused on direct effects. Although ICTs may impact energy efficiency in many areas such as transport for instance, the focus of this paper is on the electricity value chain from a demand and supply side point of view.

Electricity supply

Distributed generation – which refers both to decentralised generation of electricity from various sources and to the controlled generation of electricity in smaller power plants – is one important area where ICTs play a role. ICTs are used for wind power forecasting where measurement is crucial for the calculation of short-term expected wind power production. ICTs also support the operation of virtual power plants, which are a modular and scalable technology built from small units with high efficiency whose operation optimise the utilisation ratio of heat and power. They enable the quick adaptation of energy requirements to meet demand.

Grid management can also be supported by ICTs, which help ensure a more efficient transmission of electricity, providing technology solutions for the provision of balancing and reserve power from decentralised sources, at the level of transmission networks (high voltage lines). As to distribution networks (medium voltage lines) ICTs support intelligent tools for the stabilisation of the grid, based on communication capable inverters. However, the efficiency potential of ICTs in grid management seems to be rather limited compared to other fields of application.

Smart metering enables more accurate measurement of consumption via the use of advanced meters which are connected to a central unit through a communications network, improving data collection for billing purposes. In addition smart metering provides information on consumption patterns contributing to more sustainable consumption and energy savings.

Demand side management (DSM) which may be price or incentive-based can contribute to reducing energy consumption, lowering peak demand and thus plant management. DSM which cannot be implemented with conventional meter and billing systems would benefit from being promoted by governments.

Electricity Demand

Applying novel ICT solutions for **control systems** and **home automation** promises to have an impact on electricity demand at the level of households and much more at the level of publicly owned buildings which are professionally managed.

Building control systems enable the integrated interaction of a number of technological elements such as heating, ventilation, air conditioning, lighting, safety equipment etc. The embedding of ambient intelligence in building, thanks to advances in nanotechnologies, sensors, wireless communications and data processing contributes to for instance better temperature management, leading to reduced energy consumption.

In the area of **home automation**, which is primarily perceived as improving life quality (e.g. more comfortable, safer homes), ICTs may contribute to energy efficiency through the use of control systems based on smart appliances and communication networks. However the anticipated benefits may be outweighed by the increasing number of appliances in households which often remain in stand-by mode, increasing electricity use. Greater awareness about energy savings would help implement home automation for energy efficiency purposes even if the improvement a the level of the individual components and equipment promises to be more effective than the expected effects of optimised control.

In conclusion, ICTs can play an important role in lowering energy consumption and in optimizing the energy system. Overall, it can be expected that the individual processes in the energy sector will become more transparent due to the introduction of ICTs. Currently passive players such as household customers could become active market participants due to their incorporation into a comprehensive communication system which would open up value-added potentials for numerous service providers. The potentials provided by ICTs can only be completely and efficiently exploited if a global energy management is set up which encompasses all stages in the value-added chain, something which does not exist at present. The final consumers and decentralised energy suppliers are not incorporated into the information flows of energy producers and grid suppliers, nor are there comprehensive strategies to use the potential offered by consumer-side mechanisms. Because of the current tariff structure, many consumers do not participate in the electricity market so that real price competition does not happen.

Last but not least the following policy issues need to be considered on the way towards more ICT based energy efficiency:

- *Cross-cutting activities* such as data protection, security or framework conditions
- *Creating a communications platform and reaching an agreement on an agenda* with a view to linking all players and systems.
- *Smart Metering as migration strategy*
- *Facility management for small and medium-sized enterprises*
- *Improved management of renewable energy loads*
- *Construction and incorporation of ICT based virtual power stations*:
- *Creating empirical data on home automation*
- *Involving relevant organisations dealing with consumers and data protection*

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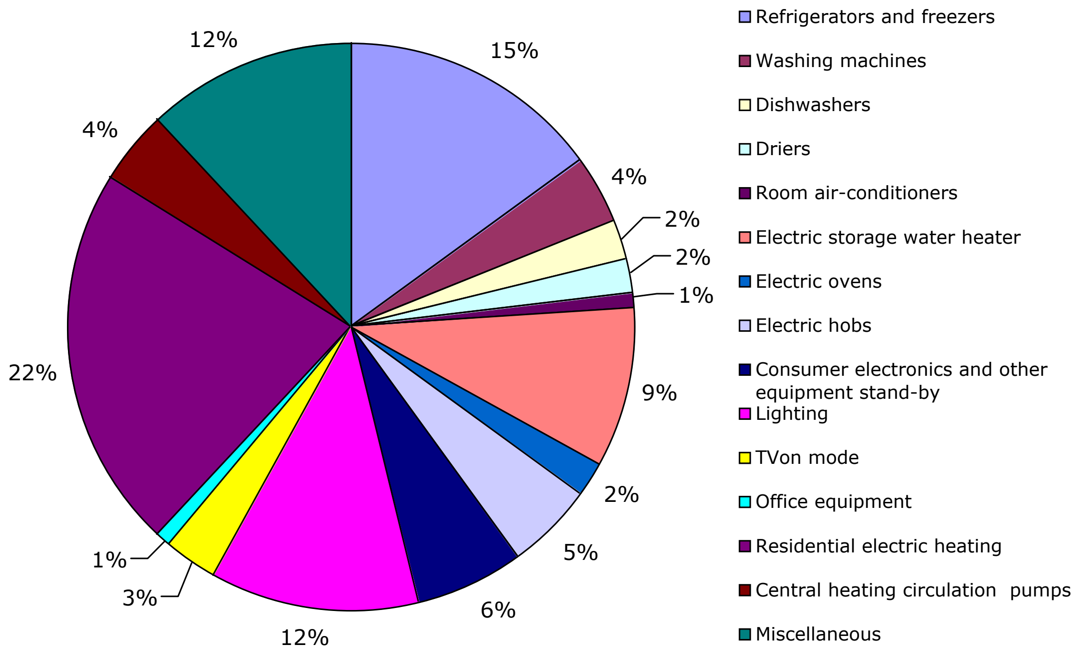
1. INTRODUCTION

1.1 MOTIVATION

ICT appliances are the fastest growing electricity end-use in the residential sector and it is expected that this will impact energy consumption in the short term. This includes more "traditional" equipment such as TVs and Hi-Fi, and "new" digital devices such as MP3 players, DVD-Recorders, Set-Top Boxes etc. Trade statistics (e.g. from EITO) show the large increase of equipment sold, considering the general trend of price decrease. But there are also trade-offs between traditional and new appliances, for instance CRT TVs and VCRs are sharply reducing their sales in favour of flat TVs and DVDs..

In 2004 the energy demand for information and communications in EU15 reached 9% of the total electricity consumption by residential equipment (see Figure 1 below). For the same year, in Germany, energy demand was estimated at almost 1.5% of the total final energy consumption, or 7.1% of the electricity consumption. Until 2010 it is forecast that ICT appliances will require almost 11% of the total German electricity consumption.[192] This trend can also be observed in other EU member states as well as the United States and Japan.

Figure 5: Breakdown of electricity consumption among residential end-use equipment in EU-15, 2004



Source: Bertoldi, P.; Atanasiu, B. (2007). Electricity Consumption and Efficiency Trends in the Enlarged European Union – Status report 2006. Technical Report Series EUR 22753 EN. Ispra: EC-JRC, Institute for Environment and Sustainability, p. 6

[192] Cremer, C.; Schlomann, B. et al. (2003): The impact of information and communication technologies on the electricity consumption in Germany. In: Proceedings of the ECEEE 2003 Summer Study, St. Raphaël, 2-7 June 2003. Paris: European Council for an Energy-Efficient Economy; Energy in Japan 2006. Tokyo: Agency for natural Resources and Energy, Ministry of Economy, Trade and Industry. 2006.

1.2 Policy Context

The publication of the fourth assessment report on climate change of the IPCC in early 2007[193] expressed once more the urgency to tackle one of the most important global challenges in terms of magnitude of the problems as well as availability of measures with sound chances for success. Mitigating climate change would require substantial additional efforts but would not cripple the global economy.

Sustainable development plays a pivotal role in the policies of the European Union to make Europe an economically prosperous region and a place worth living in. With the adoption of the renewed sustainable development strategy in June 2006,[194] comprising a wide partnership between business and civil society, European Heads of State have addressed the identified seven key challenges. ICTs are crucial to resolve these challenges and hence to mitigate the top priority problem of climate change.

The European Commission implements a sustainable development strategy by proposing measures as the "Energy Efficiency Action Plan"[195] and by further developing renewable energy strategies such as in the proposal document "An Energy Policy for Europe".[196]

Policies addressing the energy efficiency of goods and products are one field where the European Union has been very active. With the directive on labelling,[197] purchasing and investment decisions should be positively influenced by information on the energy demand and relative efficiency of products. The directive on Energy using Products (EuP-directive) addresses all kind of products driven by energy including also several ICT-devices.[198]

With the Energy Services Directive,[199] the European Union has laid further grounds for the introduction of energy services that have great potential in improving overall energy efficiency. Several principal provisions of the Energy Services Directive such as energy audits and individual metering directly call for the implementation of innovative ICT.

The European Union policies on the information society have taken up the challenge of energy efficiency and sustainability and foster the contribution of ICT to resolve the problem. Under the section quality of life, the i2010 initiative[200] specially addresses ICT as a tool for environmental sustainability. Addressing energy efficiency and environmental sustainability

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193 IPCC (2007). Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Contributions from Working Group I, Working Group II and Working Group III. Geneva. http://www.ipcc.ch.

194 Council Decision of 15/16. June 2006 on Renewed EU Sustainable Development Strategy.

195 European Commission (2006). Action Plan for Energy Efficiency: Realising the Potential. COM (2006) 545 final. Brussels. http://ec.europa.eu/energy/action_plan_energy_efficiency/doc/com_2006_0545_en.pdf.
European Commission (2007). An Energy Policy for Europe. COM (2007) 1 final. Brussels. http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0001en01.pdf

197 Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances (1992): In: Official Journal of the European Communities L 297, Nr. 13 October 1992, S. 0016 – 0019; Regulation (EC) No 2422/2001 of the European Parliament and of the Council of 6 November 2001 on a Community energy efficiency labelling programme for office equipment. (2005): In: Official Journal of the European Communities L 332.

198 EU Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council. (2005): In: Official Journal of the European Communities L 191, pp. 0029 - 0058.

199 Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC. (2006): In: Official Journal of the European Communities L 114, pp. 64-85.

200 European Commission (2005). i2010 – A European Information Society for growth and employment. COM (2005) 229 final. Brussels.

not only adds to the quality of life but more importantly has a very significant potential for jobs and growth. ICTs and ICT-based services for energy efficiency offer the opportunity for European enterprises to develop new sustaining markets not only on the European level but with a worldwide scope.

With the first year review of the i2010 initiative, the importance of energy as a focal challenge has increased and the Commission is establishing a comprehensive approach leading to the launch of a flagship initiative on ICTs for sustainable growth.

There are major market development opportunities for ICT hardware technologies, software and services which are components in energy technology systems. This presents chances for the European ICT industry characterised by a higher share of small and medium sized enterprises. The growing importance of ICTs in energy systems is also reflected by the Smart Grids activities such as the Smart Grids technology platform, the research agenda on Smart Grids and the activities in FP7. This paper therefore identifies fields of action which show potential for both the energy sector and ICT, discusses opportunities, obstacles and finally policy issues.

1.3 Effects of ICT on energy efficiency

Energy efficiency does not have a specifically close connection to ICT. However, ICT does have a potentially important impact on energy efficiency on the supply as well as on the demand side. When looking at the different effects of ICT on energy demand and energy efficiency there are mainly three possible effects that have to be taken into account:[201]

1) *Direct effects*: Over its complete life cycle ICT need electrical energy (for the production of devices, the operation of ICT systems and after a rather short time for their disposal).

2) *Indirect effects*: ICT can help to increase energy efficiency in a large number of applications by measuring and controlling the energy flux. This is possible on the supply side by controlling power grids as well as on the demand side by intelligently optimising the power demand. Indirect effects are the result of different mechanisms, e.g.

    - Information technology allows to measure and control variables that affect the performance of virtually any application. This includes not only process data in a narrow sense but also ecological or ambient data in general.

    - Communication technology allows building up optimised organisational and operational structures for all kinds of value-added processes in manufacturing as well as in services

3) *Systemic effects*: In the middle to long term systemic effects result from the large-scale application of ICT in a multitude of different application areas. While the time, cost or energy efficiency of the single application increase there are so called rebound effects that overcompensate the gained energy reduction (e.g. reduced private traffic due to E-Commerce vs. increased goods delivery traffic).[202]

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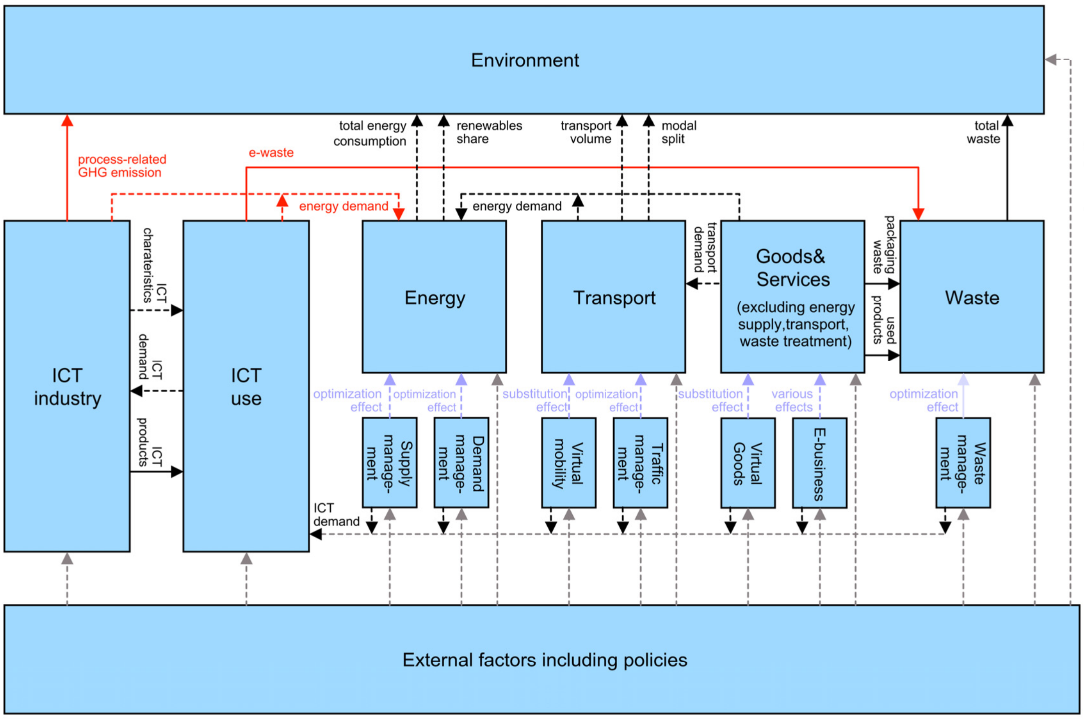
[201] See for instance Erdmann, L.; Hilty, L.; Goodman, J.; Arnfalk, P. (2004). The Future Impact of ICT on Environmental Sustainability. Technical Report EUR 21384 EN. Seville: EC-JRC, Institute for Prospective Technological Studies.

[202] See Zoche, P.; Kimpeler, S.; Joepgen, M. (2002): Virtuelle Mobilität: Ein Phänomen mit physischen Konsequenzen? Zur

While direct effects like the energy consumption of ICT devices and systems or electronic waste have been in the focus of academia, industry and policy makers for a while, indirect and systemic effects have hardly been analysed, which is why this study focuses mainly on the indirect effects of ICT on energy efficiency. However, we would like to give a brief insight into one specific type of energy-related direct effect of ICTs namely the growing electricity demand of servers and web-based applications, which – as a rebound effect - may develop into a major limiting factor of ICT growth (see section 4).

Figure 2 shows the complex interdependencies of effects that ICT has on energy efficiency (or environmental efficiency in general).

Figure 6: Complex system of effects



Source*:* Hilty, L. M.; Arnfalk, P.; Erdmann, L. et al. (2006): The relevance of information and communication technologies for environmental sustainability: A prospective simulation study. In: Environmental Modelling & Software 21, S. 1618-1629.

1.4 STRUCTURE OF THIS DOCUMENT

The following document is limited in its scope in several ways. First the focus of the analysis lies on electrical energy though for instance ICTs have a huge potential for more efficient vehicles in the form of motor or cruise control, as well as real time travel and traffic information, dynamic traffic management, cooperative systems (that support more efficiency and safety on the traffic) or road-charging (as "congestion charge") that reduces congestion and vehicle-kilometres, essentially by shifting mobility onto public transport and giving greater incentives to use low-emission vehicles. This aspect of energy efficiency has been addressed in depth in a 2004 IPTS study.[203] Also see Box 1 below for examples of case studies.

Wirkung der Nutzung von Chat, Online-Banking und Online-Reiseangeboten auf das physische Mobilitätsverhalten. Berlin und Heidelberg: Springer.

203 IPTS (2004): "The Future Impact of ICTs on Environmental Sustainability". Seville, Institute for Prospective Technological Studies, Directorate General, Joint Research Centre, European Commission.

Second the analysis only touches upon the energy efficiency of ICT itself, which is an important topic on its own covering questions like minimising stand-by losses and the substitution of less energy efficient technologies (e.g. physical traffic vs. virtual mobility).[204]

Thus the document is structured primarily along the electricity value chain in the narrow sense. Section 2 covers important issues related to the emerging needs and potentials for ICT in electricity supplies and covers topics from electricity generation, transmission to measuring and billing. Section 3 is focused on a few issues arising from the emerging needs and potentials for ICT in electricity demand. This includes mainly building control systems and home automation. Section 4 provides some examples of rebound effects related to the growing electricity consumption of certain types of ICT applications, a development that may well turn into a serious limiting factor for the further expansion of – in particular – web-based applications. The analysis is followed in section 5 by some general conclusions and policy issues.

Box 1: Examples of applications of ICT in transport

ICT for Real-time travel and trafic management : IM@GINE IT (Intelligent Mobility AGents, Advanced Positioning and Mapping Technologies IntEgration Interoperable MulTimodal, location based services), funded under FP6 IST (eSafety of road and air transports)
Project URL: http://www.imagineit-eu.com

ICT for cruise management: **Dense Traffic project :Densetraffic** -A driver assistance system to improve safety in dense traffic conditions and in the reaction to emergency situations (funded under FP5 IST)
Project URL: http://www.densetraffic.org/

ICT to reduce congestion (congestion charging and road-charging): CARTALK -an advanced driver support system based on vehicle to vehicle communication technologies (funded under FP5 IST)
Project URL: http://www.cartalk2000.net/

[204] See for instance Giesecke, S.; Kovac, R. (2007). Energieeffizienz - ein Zukunftsfeld für Österreichs IKT-Forschung. Teilstudie zum Projekt FISTA. Vienna: ARC Systems Research.

2. EMERGING NEEDS AND POTENTIALS FOR ICT IN ELECTRICITY SUPPLY

2.1 Distributed Generation

Distributed generation is a term, which is not used in a uniform way in the energy industry. On the one hand it stands for the decentralised generation of electricity from numerous small sources of renewable energy such as solar panels on roofs of private homes. On the other hand, "distributed generation" stands for the controlled generation of electricity in smaller power plants, often from cogeneration. In the following section wind power and micro CHP will exemplify the role of ICTs for the realisation of this new type of electricity supply.

Wind power forecasting

Since wind power is a very fluctuating energy resource the operator of the transmission networks needs timely, detailed and precise information about the total wind power production in a grid area to securely manage their networks and ensure an efficient use of its capacity. Basically one can assume that a measurement of all power plants in a grid area is the most exact way to support systems management and the best way to provide the data that is necessary to forecast the power feed. The need of the transmission system operators for information, however, is more difficult to satisfy because of the large number of power plants. Though these are often concentrated in wind farms, they are distributed all over the country and a measurement of all plants would be quite costly. Transmission system operators therefore use online data from a sample of representative wind farms. At the same time they use software tools capable of performing a short-term forecast of the expected total wind power production. Such systems have been developed since the mid 1990s.

The prediction technique used by most German transmission system operators is based on power measurements at a few representative wind power plants or wind parks (111 out of 16,500 wind turbines in Germany). The prediction model delivers the temporal course of the expected wind power for the control area for up to 72 hours in advance. To achieve this, locations numerical weather predictions are used to deliver meteorological parameters in one-hour intervals for a forecast period of up to three days. The corresponding predicted wind farm power is calculated using artificial neural networks. The transmission system operators then use results from the prediction model for their network management. The forecast results are compared with data from online monitoring in order to improve the performance of the forecast. In addition to the forecast of the total output of Wind Turbines for the next days (up to 72 hours), short- term high-resolution forecasts of intermittent generation in specific network regions or for wind farms and their clustering are the basis for a secure power system management. For short time forecasts (15-minutes to 8 hours) for specific sites the system is not only using meteorological values but also online power measurements from the respective site.[205]

[205] Rohrig, K.; Lange, B. (2006). Application of wind power prediction tools for power system operations. IEEE Power Engineering Society General Meeting. Montreal, Canada, 18-22 June 2006, IEEE; Lange, B.; Rohrig, K.; Ernst, B. et al. (2006). Wind power prediction in Germany – Recent advances and future challenges. European Wind Energy Conference and Exhibition (EWEC 2006). Athens, Greece, 27 February - 2 March 2006.

Similar systems are in use or under development in other European countries[206] (like the ARMINE Wind Power Prediction System in France,[207] the Multi-Scheme Ensemble Prediction System in Denmark and Ireland[208] or the 3Tier System in North America[209]). In the EU funded ANEMOS project (2002-06), a system was developed that substantially improved the methods for short-term wind power forecasting and responded specifically to the needs of different end-users by developing techniques for single wind farms, for regional and national forecasts and for different time scales. It also covered difficult weather conditions, complex terrain and the specifics of offshore wind parks.[210] Though the accuracy of today's methods reaches some 96 % for a 4 hours forecast and 94 % for a day ahead forecast there is still a need to develop better prediction methods that can take into account all statistical and geographical information in addition to real-time data.

The commercial potential of a broader deployment of real-time measurement is, however, limited. For the purpose of more accurate forecasts an increased number of measurements only leads to an incremental improvement of the forecast that is disproportionate to the costs. Beyond forecasting real-time information from wind power plants it can be used for a variety of additional purposes. The monitoring of system states could be a possibility for defect detection and remote service that help to reduce downtimes and increase the efficiency of distributed and renewable sources. For these applications it is essential to standardise information and to develop solutions that ensure confidentiality and the integrity of information.[211]

Similar solutions would also be possible for photovoltaic (PV) power plants. Due to the greater number of PV installations, the economic potential of ICT solutions is much bigger than for wind power. However the advantages lie mainly with network operators and energy suppliers who would be able to integrate PV into their schedule.

Combined heat and power plants and virtual power plants (VPP)

Energy must be provided as low-priced and reliable as possible. Competition on the international market, however, has forced many suppliers to reduce their renewing investments and to implement safeguard concepts in their existing plants. The use of so-called *virtual power plants*, is one possibility to solve this problem. Virtual power plants are a modular and scalable technology built up from small units with a high efficiency. Operation of these units will optimise the utilisation ratio of heat and electric energy. Further advantage is that by fast load and speed changes of micro plants, the energy requirements can be changed quickly to meet the demand. Thus the goal of a virtual power plant is to couple a cluster of decentralised units so that they can be collectively run by a central control entity using computer-aided tools or Energy Management System, (see Figure 3).

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206 For an overview see Giebel, G.; Brownsword, R.; Kariniotakis, G. (2003). The State-Of-The-Art in Short-Term Prediction of Wind Power: A Literature Overview. ANEMOS Deliverable D1.1. http://anemos.cma.fr/download/ANEMOS_D1.1_StateOfTheArt_v1.1.pdf.

207 http://www-cenerg.cma.fr/prediction/

208 http://www.mseps.net/

209 http://www.3tiergroup.com/en/html/wind/wind_powersight.html

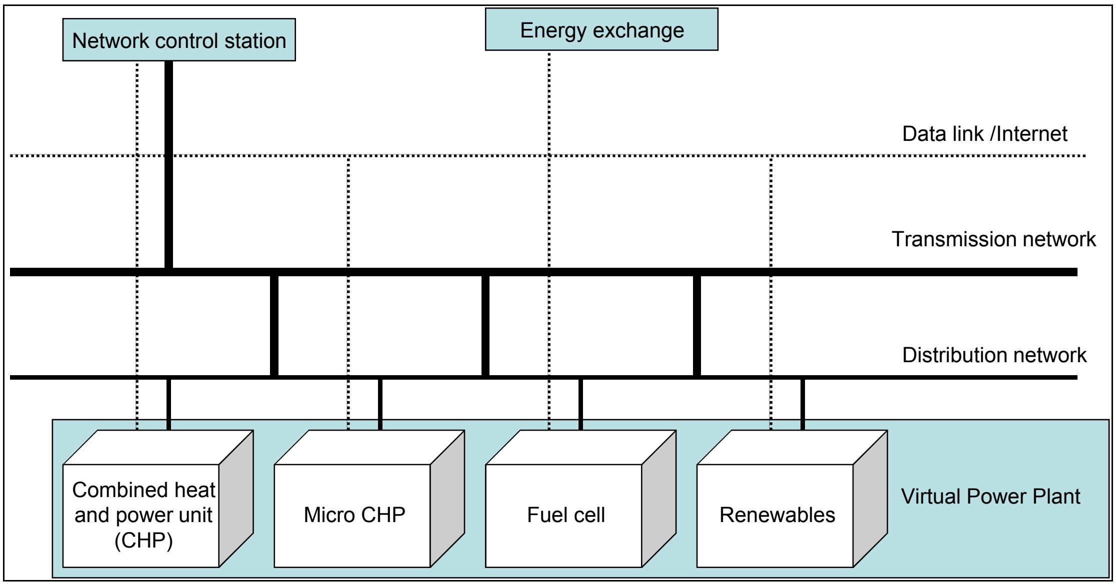
210 Kariniotakis, G.; Waldl, H.-P.; Marti, I. et al. (2006): Next generation forecasting tools for the optimal management of wind generation. In: Proceedings of the 9th International Conference on Probabilistic Methods Applied to Power Systems (PMAPS 2006), Stockholm, Sweden - June 11-15, 2006: IEEE, pp. 1-6; Kariniotakis, G.; Halliday, J.; Brownsword, R. et al. (2006). Next Generation Short-Term Forecasting of Wind Power – Overview of the ANEMOS Project. European Wind Energy Conference and Exhibition (EWEC 2006). Athens, Greece, 27 February - 2 March 2006.

211 VDE (2006). Versorgungsqualität im deutschen Stromversorgungssystem. Frankfurt: Energietechnische Gesellschaft im VDE.

In principle any kind of generation unit can be a component of a virtual power plant. For technical and economic reasons virtual power plants normally use only a small range of generation technologies, in particular combined heat and power units, fuel cells, photovoltaic and other renewable energy sources.[212] Among these the combined heat and power (CHP) technology (especially micro CHPs) has the highest potential for the integration into a virtual power plant. Micro CHP is a distributed energy resource on the scale of one household or small business. Instead of burning fuel to merely heat the building or hot water, some of the energy is converted to electricity in addition to heat. Small CHP installations can use different technologies: internal combustion engines, Stirling engines, closed cycle steam engines and fuel cells.

The concerted operational mode of a virtual power plan shall result in an extra benefit as to deliver peak load electricity or balancing power at short notice. Especially fuel cell or gas CHP units promise fast load changes and are thus suitable not only for the base load but also for middle and peak load. Once fuel cell technology has reached maturity – as experts expect in the next decade – ICT solutions for the integration of micro CHPs into virtual power plants may become a mass market, albeit with a longer time horizon than what is normally the case for the ICT industry gloablly.[213]

Figure 7: Structure of a Virtual Power Plant



212 Wind energy converters do not fit into the concept of virtual power plants because large wind farms are normally located far off the customers and have such a high power output that they feed directly into the high-voltage network.

213 Sander, K.; Barth, R.; Weber, C. et al. (2004). Brennstoffzellen-Heizgeräte: Systemvergleich und Analyse der Einbindung in zukünftige Energieversorgungsstrukturen. Project report. Stuttgart: Universität Stuttgart, Institut für Energiewirtschaft und rationelle Energieanwendung.

2.2 GRID MANAGEMENT

Current trends and emerging developments

ICT can also support the management of the power grid and help to realise a more efficient transmission of electricity.

On the level of transmission networks (high-voltage lines) the general aim is to provide the amount of electrical energy that is currently demanded. This means that the producers need to forecast the future demand and plan their capacities accordingly. The planning of capacities is done day-ahead internally by the producers and by trading mechanisms. In reality, however, there are always “disturbances” that results in a deviation from the forecasted demand and the scheduled generation of power. Transmission system operators therefore have to access balancing or reserve power in order to guarantee the stability of the grid. ICTs play an important role in this, although not a crucial one. However, the management of the integrated network was realised long before the advent of ICTs. ICTs do play a role for secondary control but use rather simple technological solutions. They also provide potential for the provision of balancing and reserve power from decentralised sources.

On the level of the distribution networks (medium-voltage lines) the increasing share of electric power feed from decentralised generators affects the quality of electricity supply and imposes severe challenges to the management of the networks. Apart from central interventions it is possible to provide decentralised services for the stabilisation of the grid with the help of intelligent power electronics (power inverters used in PV installations used as Power Quality Module). For the realisation of these services it is necessary that operators of PV plants install communication-capable inverters that can be controlled by the central grid management. The necessary technologies are available on the market (though not in large quantities). However there are no incentives for citizens because they need to invest in more expensive inverters while it is currently more profitable to produce effective power instead of providing system services for the stability and quality of power supply.[214]

Implications

Overall a recent study by Franz et al. (2006) has come to the conclusion that the potential impact of ICT for grid management on energy efficiency is rather limited compared to other measures and other application fields.[215]

2.3 SMART METERING

Current trends and emerging developments

A smart meter generally refers to a type of advanced meter that identifies consumption in greater detail than a conventional meter, and communicates this information via the network back to the local utility for monitoring and billing purposes (Automated Meter Reading, AMR). Figure 4 below shows the possible data flow enabled by the wide diffusion of AMR.

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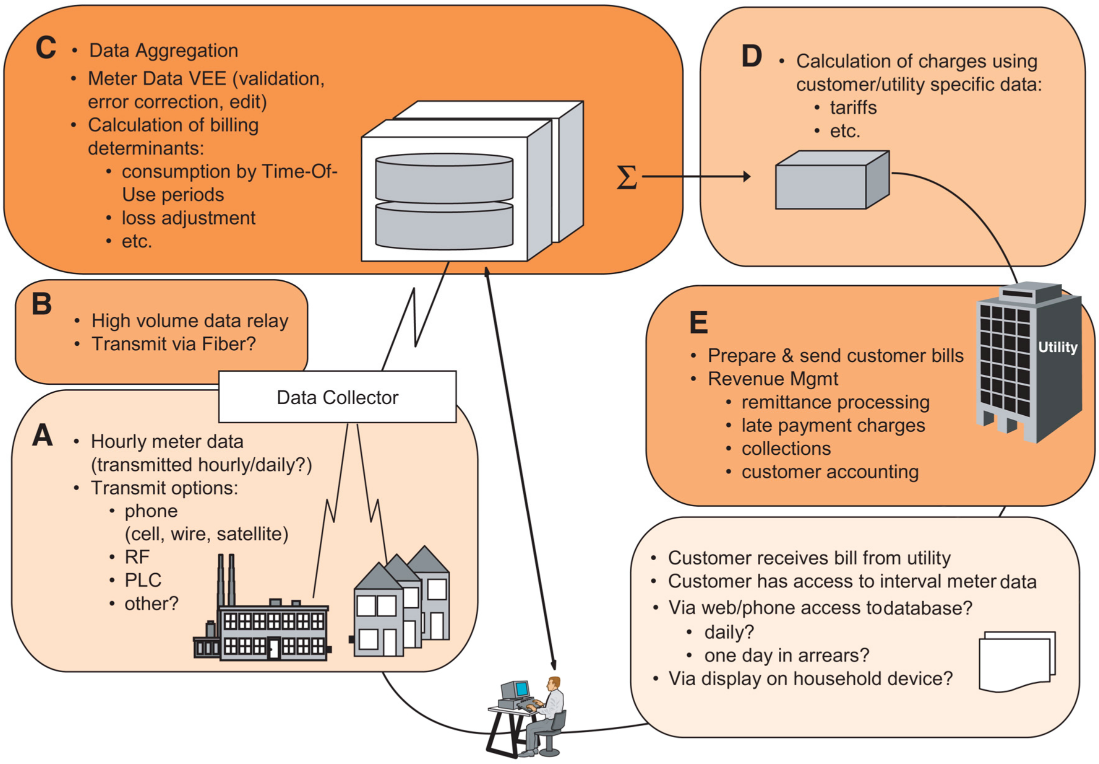
[214] These system services may include reactive power compensation, power factor correction, short power provision, local voltage stabilisation, and uninterruptible power supply.

[215] Franz, O.; Wissner, M.; Büllingen, F. et al. (2006). Potenziale der Informations- und Kommunkations-Technologien zur Optimierung der Energieversorgung und des Energieverbrauchs. Studie für das Bundesministerium für Wirtschaft und Technologie. Bad Honnef: WIK-Consult; Fraunhofer-Verbund Energie.

Figure 8: Possible AMR data flow



Source: Houseman, D. (2005). Smart Metering: The holy grail of demand-side energy management? Capgemini.

Using smart meters merely for data collection and billing purposes does not exploit their potential to the full. In fact smart meters close the information gap for understanding energy use pattern and implementing more efficient control mechanisms (see Figure 4). They are offering electricity and gas customers the following additional advantages:

- More accurate bills i.e. less bills based on estimated use
- Information that could help them use less energy and encourage investment in energy efficiency
- Lower costs through reduced peak consumption, because this would reduce the need for new network investment
- Increased security of supply because the less energy is used, the less is needed
- More sustainable consumption through reduced carbon emissions.

Smart metering systems are being marketed by commercial companies, allowing for instance comparison of energy consumption between branches of a company, or enabling individual users to see their consumption pattern and adopt appropriate measures for energy saving.

Since multiple actors are involved (customers, network operators, energy suppliers) it is necessary for a functioning liberalised market that the information is provided in a way that allows an unproblematic change of the supplier, i.e. there is a need for (internationally) standardised data formats. Moreover smart metering can be the basis of a more efficient use of energy and the provision on new energy services. For this reason data formats have to be compatible to existing software systems (Customer Relations Management, Energy Data Management).

Of all smart meter technology elements the crucial technological challenge is communication. Each meter must be able to reliably and securely communicate the information collected to some central location. Considering the fact that meters are placed in a variety of environments and locations, that problem can be very difficult to solve. Among the solutions proposed are the use of cellular networks (GSM/UMTS) and wireless connections, but also fixed line communications like DSL lines or power line communication. To date no single solution seems to be optimal for all applications. Rural utilities experience very different communication issues than urban utilities or utilities located in challenging locations such as mountainous regions or areas ill served by wireless and internet companies.

Implications

In most European countries energy consumption is still measured with conventional "Ferraris",[216] or induction-type, meters that can only measure the overall consumption. With these meters it is, therefore, not possible to measure the individual energy demand over time. The EU directive on energy end-use efficiency and energy services,[217] however, requests the installation of individualised meters that can inform end-users about their actual energy consumption. The changed framework conditions offer new market opportunities. Energy suppliers and other enterprises set up metering companies that offer their services not only to their own network branches but also to third parties. Large service enterprises that already offer metering services for the heat market develop concepts for entering the market for gas and electricity metering.

Box 2: Examples of smart metering in Europe and abroad

United Kingdom: A consortium is planning an AMR pilot project with approximately 1000 household customers. The project aims at reading existing meters optically and transmitting the data over TV cable or satellite links. Over TV cable power supplier receives metering data while customers receive information about tariffs, which are displayed on the TV set. If only a satellite link is available metering data is transmitted over GPRS or another packet switched network.

Italy: Over a 5-year period beginning in 2000 and ending in 2005 Enel invested 5 billion EUR for deploying smart meters to its entire customer base (30 million). Motivation: Cost savings for administration, reduction of electricity theft, stabilisation of the grid by reducing peak load during summer time. Enel is offering their customers a multitude of different tariffs. Meters were developed together with IBM and include a PLC modem for transmitting data to a so-called concentrator, which acts as the interface to existing IP-networks. Most meters are read via a GSM link because this network has the broadest coverage.

Netherlands: The Dutch ministry of economic affairs has decided in February 2006 to replace all electricity and gas meters by AMR systems. For the implementation a project group was installed that analyses the main advantages of AMR systems and defines the main functionalities.

Canada: The Ontario Energy Board in Ontario, Canada has actively strived to define the technology and develop the regulatory framework around their implementation. Smart meters will be installed in 800,000 homes by 2007, with an eventual goal of 100% penetration by 2010.

Source: Baldock, M.; Fenwick, L. (2006). Domestic Metering Innovation. Consultation Report. London: Office of Gas and Electricity Markets (Ofgem).

2.4 DEMAND-SIDE MANAGEMENT

Current trends and emerging developments

Energy demand management entails actions that influence the quantity or patterns of use of energy consumed by end users, such as actions targeting reduction of peak demand during periods when energy-supply systems are constrained. Peak demand management does not

[216] Basic instrument for measuring domestic power used for many decades

[217] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC. (2006): In: Official Journal of the European Communities L 114, pp. 64-85.

necessarily decrease total energy consumption but could be expected to reduce the need for investments in networks and/or power plants. Demand side management (DSM) is sometimes also called demand response (DR).

In electricity grids, demand response refers to mechanisms to manage the demand from customers in response to supply conditions, for example, having electricity customers reduce their consumption at critical times or in response to market prices. Most electricity customers see electricity rates that are based on average electricity costs and bear little relation to the true production costs of electricity as they vary over time.[218] Demand response can be:

- *Price-based* e.g. real-time pricing (RTP), critical-peak pricing (CPP) or time-of-use (TOU) tariffs), where users tend to use less electricity when it is more expensive.
- *Incentive-based* where customers participating in the scheme receive a monetary incentive to reduce their loads at times defined in the scheme.

Demand response generally refers to mechanisms used to encourage consumers to reduce demand, thereby reducing the peak demand for electricity. Since electrical systems are generally sized to correspond to peak demand (plus margin for error and unforeseen events), lowering peak demand reduces overall plant and capital cost requirements. Depending on the configuration of generation capacity, however, demand response may also be used to increase demand (load) at times of high production and low demand.

Impact on energy efficiency

The most important benefit of demand response is improved resource-efficiency of electricity production due to closer alignment between customers' electricity prices and the value they place on electricity. This increased efficiency creates a variety of benefits, which fall into four groups:[219]

- *Participant financial benefits* (e.g. bill savings and incentive payments for customers participating in such programmes)
- *Market financial benefits* (e.g. lower wholesale market prices)
- *Reliability benefits* (e.g. operational security and savings linked to the reduction in forced outages)
- *Market performance benefits* (increased competition)

Implications

Price-based demand response cannot be achieved immediately for all customers. Conventional metering and billing systems for most customers are not adequate for charging time-varying rates and most customers are not used to making electricity decisions on a daily or hourly basis. The transformation to time-varying retail rates will not happen quickly. Consequently, fostering demand response through incentive-based programs will help improve efficiency and reliability while price-based demand response grows.

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[218] Since changing the users' consumers' day-to-day behaviour is a difficult task actors such as the Pacific Northwest National Lab in the US have started developing so called Grid friendly appliances that are designed to respond automatically to the changing price level and thus allow to reduce energy costs by using less electricity when prices are high, and more electricity when prices are low. See: http://www.gridwise.pnl.gov

[219] FERC (Federal Energy Regulatory Commission) (2006). Assessment of Demand Response and Advanced Metering. Staff Report AD06-2-000. Washington.

According to Didden and D’haeseleer (2003) mainly end-users and manufacturers of efficient equipment will profit from DSM. The most powerful actors, manufacturers of conventional equipment, primary energy suppliers and utilities, however, will not financially benefit in the same way. Therefore it seems necessary that governments actively promote the creation of a suitable framework for demand side management.[220]

3. EMERGING NEEDS AND POTENTIALS FOR ICT IN ELECTRICITY DEMAND

Building control systems and home automation are two main areas where the application of novel ICT solutions promises to have an impact on electricity demand at the level of households as well as of public and business buildings. The two areas are not clearly delimited from one another. Home automation/smart homes cover a broad range of “intelligent” solutions in the household, with the emphasis being put on all kinds of appliances to facilitate household operations (e.g. cleaning, washing, cooking, audio-visual entertainment, etc.) and/or to enhance security (e.g. access control, monitoring, etc.). Building control systems usually have a more specific focus; they are related to the automated control of the ambient climate in a building, thus covering the optimisation of heating/cooling systems, using a range of novel technologies like e.g. sensors, intelligent windows, etc. The optimisation in terms of electricity and/or energy demand can be an important aspect to be considered here, although comfort may be an equally important driving force for the introduction of intelligent building control systems.

3.1 BUILDING CONTROL SYSTEMS

Current trends and emerging developments

Building control systems are intended to improve the quality of comfort, health and safety conditions of indoor environments in an effective and efficient manner. In contrast to active passive energy efficiency measures (e.g. insulation) and conventional heating/cooling technologies, building control systems have been introduced to ensure the integrated interaction of a much broader range of technological elements (heating, ventilating, air-conditioning (HVAC), lighting, life safety equipment, architecture), and of humans who live/work in them in order to influence the indoor environment. Recent developments in nanotechnology (e.g. windows, surfaces), sensor/actuator technology, wireless communication technology, and data processing and control have enabled the embedding of ambient intelligence in buildings.

The current developments are captured nicely by Arens et al. (2005):

“Ambient intelligence has the potential to profoundly affect future building operations. Recent breakthroughs in wireless sensor network technology will permit,

- highly flexible location of sensors and actuators,
- increased numbers and types of sensors informing more highly distributed control systems,
- occupants’ involvement in control loops,

[220] Didden, M. H.; D’haeseleer, W. D. (2003): Demand Side Management in a competitive European market: Who should be responsible for its implementation? In: Energy Policy 31, pp. 1307–1314.

- demand responsive electricity management,
- integration among now-separate building systems, and
- the adoption of mixed-mode and other new types of air conditioning systems that require more sensor information to operate efficiently."

The realisation of the potential of building control systems depends to a significant extent on the quality of their operation. The growing importance of specialised energy service companies (not the least a result of the liberalisation of the energy supply sector) that are taking care of a cost- and (thus energy-) efficient management of facilities, especially in public and business buildings, ensures that this potential can indeed be reaped. Here, business interests in cutting costs tend to go hand in hand with expected benefits in terms of electricity consumption – at least for the coming years. Marginal cost consideration may lead to a levelling out of the economic (and thus also the efficiency) gains to be achieved.

For private housing, intelligent building control systems need to rely on a high level of user-friendliness to be operated efficiently and to the satisfaction of the inhabitants. Although some of the typical barriers to the uptake of home automation technology by private users (see next section) also apply to building control systems, they tend to be perceived as less problematic. Acceptance of sophisticated control systems is higher, and the scepticism about user-friendliness and impact on individuals' autonomy less pronounced.

Impacts on energy efficiency

Energy efficiency may not be the only motivation behind the introduction of building control systems, but it is certainly an important one, driven not the least by cost considerations. Moreover, in professionally managed building, cost considerations tend to support the interest in reducing energy (and electricity) consumption. Although the initial investments in advanced building control systems can be quite significant, declining costs for sensors, actuators and ICT equipment in conjunction with the cost savings over the life-time of the equipment tend to make the introduction of building control systems a promising investment.

Investment in intelligent building control systems must be compared to other investment options in energy efficiency. Moreover, the right level of sophistication needed for building control systems may be a source of debate. Comparatively simple building control systems may be sufficient to reap quite significant economic benefits. This is a strong argument especially in relation to the upgrading of existing buildings, where the retrofitting of major new physical components may be difficult, but some soft ICT-based measures are comparatively easy to implement.

For instance, ICT applications for heating management have a high potential impact on the rational use of heating energy. Heating accounts for roughly 30% of total energy consumption, and the most effective conservation measures using physical materials tend only to be applied to the small annual share of buildings that is renovated or newly built. 'Soft measures' using ICTs (such as intelligent heating systems) have the advantage of being applicable in all kinds of buildings, both old and new, and could therefore have a significant effect. The use of ICT applications for heat management should therefore be a priority for future research and development.

Implications

Overall, the impact of housing control systems could be quite significant:

- In view of the large number of publicly owned buildings, the public sector has a major role to play in the promotion for advanced building control systems and possibly the creation of critical mass for economies of scale.
- Barriers to adoption exist, but are less problematic than in the case of home automation, because professional service providers and professional users contribute to ensuring that information barriers and operational difficulties are overcome. However, with economic considerations being a major driver of introducing building control systems, it is not necessarily the most sophisticated technologies that will be introduced.
- In view of the large number of public buildings suitable for building control systems, innovation-oriented public procurement could turn into a main lever for accelerating the emergence of a lead market for the most advanced variants of building control technologies, and thus for their wider diffusion. In general, there is already a quite developed market for professional facility management that could be stimulated to adopt more advanced solutions.

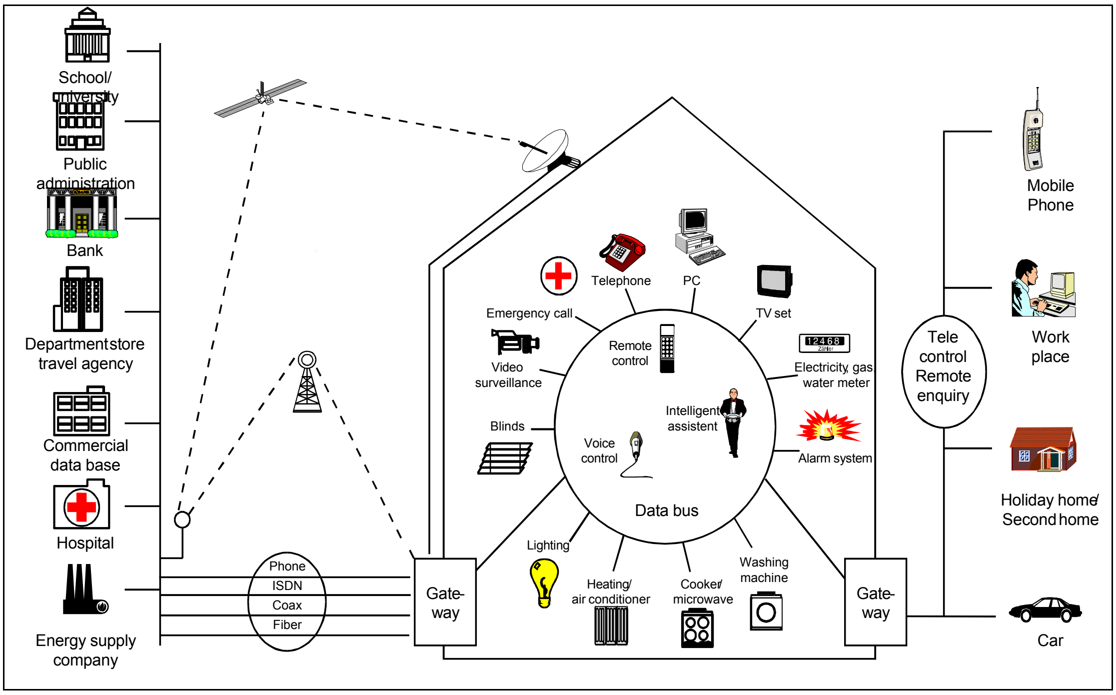
3.2 HOME AUTOMATION

Current trends and emerging developments

The concept of home automation (or smart homes) comprises a whole set of intelligent household appliances that are inter-connected and automatically controlled using advanced ICTs. As captured by Figure 5 below, a central interface integrates the data flows to and from the different appliances. They can be connected to external service providers by any of the existing communication infrastructures (fixed line, mobile, satellite, etc.). The connection and remote access to and from the automated household services to and from other locations (e.g. workplace, on the move) offers manifold opportunities for making life at home more comfortable, safe and – though not being the prime objective – energy efficient, ranging from health monitoring/ambient assisted living to the adaptation of the home environment to the mood of the user (e.g. in terms of colours, light, music, entertainment, etc.). A futuristic vision of life in an intelligent home environment is captured, for instance, in the ambient intelligence scenario developed on request of ISTAG.[221]

[221] See IST Advisory Group; Ducatel, K.; Bogdanowicz, M. et al. (2001). Scenarios for Ambient Intelligence in 2010. EUR 19763 EN. Seville: EC-JRC, Institute for Prospective Technological Studies (IPTS).

Figure 9: Functional Architecture of Home Automation / Smart Home



Source: WIK-Consult, Bad Honnef

Experts regard the development of home automation as technically feasible. The communication infrastructure technologies are available, as are the necessary smart household appliances. Earlier restrictions to the networking of appliances in terms of addresses available for the large number of appliances in a household can be overcome by the new Internet protocol (IPv6).

The technical, but also the social feasibility of smart homes has been demonstrated in a number of pilot projects. Still, diffusion is delayed for a number of reasons:

- Lack of information about the maturity of home automation
- uncertainty about the cost-benefit ratio,
- uncertainty about the pace of technological change in home automation technology and the emergence of new standards,
- scepticism about a growing dependence on autonomous technical devices, and thus a fear of a lack of own autonomy by users,
- concerns about potential negative health impact of, in particular, new wireless technologies and
- insufficient user-friendliness and ease of use of home automation systems, requiring users to unlearn established practices and get used to new routines.
- The greater ease of realising home automation in new building as compared to the upgrading of the infrastructure in existing building, in conjunction with the long life cycles of buildings, prevents a faster uptake.

- Innovation-averse procurement practices (still) delay the creation of lead markets in home automation technology, as long as their cost effectiveness and reliability is not proven.

Impacts on energy efficiency

Technically, the realisation of an energy-intelligent household by means of smart appliances depends on the availability of communication intelligence to enable load management, and thus standard interfaces. With IPv6 becoming available and turning possibly into a new standard for home automation, one of the few remaining technical barriers seems to become obsolete. However, in contrast to building control systems, the main motivation behind the introduction of home automation is not to optimize energy and electricity consumption, but to increase the comfort and the security of its inhabitants, to make their lives easier.

Moreover, as a first and direct impact, even the most intelligent appliances increase rather than decrease electricity consumption. Over the past years the electricity consumption of households has tended to increase significantly due to the growing number of electronic devices used and rising comfort expectations, leading to e.g. larger refrigerators, TVs, use of standby function. The possibilities offered by a more intelligent and efficient operation of household appliances as one of the possible elements in the context of home automation can contribute to reducing electricity demand or at least containing the likely further increase. The net effects are still uncertain and depend on a range of other factors. A Swiss study[222] argues, “the induced increase in energy demand is probably far more significant than the quantity of energy saved by more efficient control.”

Whether the possibility of optimising the energy efficient operation of household appliances will actually be realised depends on the willingness of users to consciously use the technology for that purpose. So far, there is little evidence that this will be the case.

Finally, the potential of home automation to contribute to reducing electricity consumption at household level needs to be compared to other measures, especially the improvement of electrical efficiency at the level of individual components and equipment, which is likely to be much more effective than the expected effects of optimised control, especially in stand-by and off modes.

Implications

Overall, the impact of home automation – as contrasted here to building control systems – seems rather limited, for three main reasons:

- Compared to efficiency measures at the level of individual components, the reduction of electricity consumption due to the use of house automation seems rather limited. On the contrary, home automation is expected to contribute quite significantly to the expected future increases of electricity consumption at household level.
- Home automation is done in the first instance for purposes of convenience, safety and comfort, not for reasons of energy saving.

[222] Aebischer, B (CEPE, ETHZ) and Huser,A (Encontrol GmbH) on behalf of Swiss Federal Office of Energy: "Networking in private households - Impacts on electricity consumption" (2000)

- There are still important barriers to a widespread uptake of home automation in the personal environment, due to concerns about intrusion in the private sphere and a perceived loss of autonomy, issues that are less problematic in a work environment.

4. ENERGY-RELATED REBOUND EFFECTS OF ICT DIFFUSION

Erdmann et al. (2004) explains that forecasts have consistently overestimated the positive effects of “intelligent traffic systems” because they disregarded important rebound effects. The acceleration of road traffic by means of traffic management and satellite navigation systems indirectly leads to more traffic because people are having a rather stable time budget for individual mobility.

A more recent example is the question of the sustainability of virtual worlds: LindenLab’s CEO Philip Rosedale indicated that the servers hosting the virtual world are running at full power all the time, so LindenLab consumes an enormous amount of electricity: "We're running out of power for the square feet of rack space that we've got machines in. We can't for example use [blade] servers right now because they would simply require more electricity than you could get for the floor space they occupy." Theoretical calculations have shown that the per-capita energy consumption of an avatar in SecondLife is about 1,752 kWh per year, which is comparable to the energy-consumption of an average Brazilian citizen who consume 1,884 kWh per year in real life.[223]

The number of server farms is increasing constantly, a trend supported by the booming of web applications and services, web hosting, online shops, internet access provision or search engines for instance. Every time a Web search request is made on Yahoo, for example, roughly 7,000 or more computers are activated and at least 15,000 others support every query by constantly searching around the Net for updates.[224] In sectors like banking or the airline business data storage and processing are subcontracted to external providers which maintain always higher numbers of servers. Those require energy to work but also to be cooled down. In the meantime Google alone maintains a server farm network of nearly 500,000 servers. According to a study commissioned by Advanced Micro Devices (AMD), between 2000 and 2005 energy consumption from the Internet has doubled in the US reaching 45 billion kWh, 1.2% of the total US electricity consumption.[225]

The impact of internet and computer use on energy consumption is such that the concerned undertakings have started looking into more efficient solutions to reduce their electricity consumption. Possible options for electricity savings include sleep mode when a computer is idle (a function that is not activated in most PCs due to conflict with software), thin clients where all processing is done centrally leaving users with screens and keyboards thereby reducing electricity consumption by 90%, the development of more efficient processors as well as advanced cooling methods or optimised software.[226] AMD, for example, is pushing its Opteron chips as an energy-efficient solution for data centers (Opteron puts two lower-power

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[223] See Nick Carr. Avatars consume as much electricity as Brazilians. http://www.roughtype.com/archives/2006/12/avatars_consume.php (posted 05 December 2006).

[224] http://money.cnn.com/2006/07/26/magazines/fortune/futureoftech_serverfarm.fortune/index.htm

[225] See press release at www.amd.com/us-en/Corporate/VirtualPressRoom/0,,51_104_543~115850,00.html and http://enterprise.amd.com/us-en/AMD-Business/Technology-Home/Power-Management.aspx

[226] See DIE ZEIT, 09.08.2007 Nr. 33 at http://www.zeit.de/2007/33/T-Green-Computing (German language)

processors on a single chip, reducing the electricity needs of servers that use it). Open-source solutions are also used to save electricity.[227]

A consortium of information technology companies – The Green Grid[228] – was launched in February 2007 with a view to improve energy efficiency of data centres around the world. Its first plans were unveiled in a roadmap for 2007 which will focus on "data collection through the documentation of existing standards and the evaluation of metrics; data assessment through a market study of current efficiency practices; and technology proposals that outline The Green Grid's recommendations for the future of energy efficient data centres". The consortium counts over 50 members including major players which reveals an increasing awareness for energy efficiency matters.

Beyond server-farms, the new access conduits, advertised as triple play are also energy-hungry, as highlighted by French consumer associations which have looked into the impact on electricity bills of triple-play offerings (i.e. combined provision of internet, telephony and TV services). While contributing to savings on users' communications bills they have an important adverse effect on their electricity bills. In France the yearly energy consumption incurred by triple play boxes which have to stay connected continuously and use more electricity to run than other household appliances reaches 1.51 billion kWh or the equivalent of one nuclear reactor producing energy for two and a half months.

The issue of rebound effects goes beyond the scope of this ETU which is why this section is not going into in-depth analysis of the topic, but the above examples provide an insight into developments that would deserve further work and will require closer attention of policy makers in the near future.

5. POLICY CONCLUSIONS AND POLICY ISSUES

Information and communication technologies can play an important role in lowering energy consumption and in optimizing the energy system, since they can help to address fundamental problems in the electricity sector which result from the grid dependency and the non-storability of electricity: supply has to be able to react to the demand resulting from the decentralized decisions of households and companies at any time if congestion or overloading of the system is to be avoided – it is important to note here that both too high and too low demand may trigger instability in the system.

If, against the background of the ICT developments, it is assumed that bytes will become cheaper than steel and iron, then the advantages of an information "revolution" in the European energy industry are obvious. There are considerable potentials in many areas if corresponding investments are made and institutional obstacles overcome. In the household sector, potentials exist primarily in actually being able to see what energy is being consumed and the savings consumers can make as a result as well as in the introduction of time-dependent tariffs. For this to happen, intelligent metering systems have to be introduced which not only lead to greater price awareness on the part of consumers but also automate processes such as switching supplier or measuring and billing as well as serving as the

[227] http://www.wired.com/wired/archive/14.10/cloudware_pr.htm
[228] http://www.thegreengrid.org/home

interface for more advanced processes such as those involved in home automation.[229] "Smart metering" is also an interesting issue for the majority of companies who believe that they can improve their economic efficiency by introducing the new technology.

Overall, it can be expected that the individual processes in the energy sector will become more transparent due to the introduction of ICTs. Currently passive players such as household customers could become active market participants due to their incorporation into a comprehensive communication system, which would open up value added potentials for numerous service providers. The technology for such a scenario already exists in most areas today.

The potentials viable with ICTs can only be completely and efficiently exploited if a global energy management is installed which encompasses all stages in the value added chain. Such a management programme, which accounts for changes in the production structure due to the increase in decentralized units and also for consumer-side measures such as demand-side management programmes or the progress made in building services engineering does not exist at present. The final consumers and decentralized energy suppliers are not incorporated into the information flows of energy producers and grid suppliers, nor are there comprehensive strategies to use the potential offered by consumer-side mechanisms.

Because of the current tariff structure, numerous consumers do not participate in the electricity market so that real price competition does not take place. Communication between the participating players, if it takes place at all, is mainly unidirectional although the corresponding technology for bidirectional communication is already available for majority of options presented here. From an economic perspective this is unsatisfactory as long as the total degree of efficiency of energy supply could be increased and the costs for this are lower than the benefit gained.

Problems with the implementation of such a global system result from the combination of previous, mainly proprietary systems. Here it should be asked if the manufacturers of these technologies have any interest in agreeing on uniform standards, data formats and processes in processing and passing on information while it is still open who should have access to which data and is allowed to do so without violating the privacy of the players involved.

Standardized data formats can also be used to automate customer administration processes at the energy supply companies (changing supplier etc.) – but this would also be suited to giving a renewed push to the liberalization of the electricity markets and thus making the system more competitive. Such an approach should ensure that the applied technology is flexible both spatially and temporally (adaptation to newer developments).

Overall the following policy issues exist on the way towards more energy efficiency:

Cross-cutting activities: For the successful realisation of the potential it is essential that the relevant prerequisites are created in the pre-competitive domain. It must be guaranteed that technological solutions can really be used, are legally compatible, have a broad impact and do not fail because of questions of data protection, data security or other framework conditions. A complete analysis of this problem area is therefore advisable; the removal of any possible

[229] However there is still a controversy if direct or indirect feedback really leads to a change in the consumers' day-to-day behaviour. See for instance Darby, S. (2006). The effectiveness of feedback on energy consumption. A review for DEFRA of the literature on metering, billing and direct displays. Oxford: Environmental Change Institute, University of Oxford.

obstacles in this field constitutes a task for governments. In particular, such cross-cutting activities should be designed to take into account the objectives of interoperability and standardization of the processes and data.

Creating a communications platform and reaching an agreement on a agenda: The intensification of competition and the growing decentralization of energy supply make it important that all the players and systems involved across all stages of the value added chain are linked via a telecommunications network if the relevant processes are to be organized more effectively and efficiently in the future. Networking is not solely a technical issue; first and foremost it means creating a communicative platform for the relevant players (possibly enabled by a European industry association). The task of the participants would be to agree on a uniform agenda for the implementation, to pose the relevant questions, identify shared and conflicting interests, determine drivers and market obstacles, develop strategies to overcome these, etc.

Smart Metering as migration strategy: Smart metering can serve as an important gateway for access to more sophisticated ICT systems supporting energy efficiency. Metering technology as the interface between grid operators/energy suppliers and end-users can serve as a bridge to home networks. Here it also seems advisable to examine the customers' knowledge, information required, willingness-to-pay, obstacles, acceptance and possible incentives. However, smart metering is indispensable as the prerequisite for DSM programmes and thus more efficient grid management.

Facility management for small and medium-sized enterprises: SMEs comprise an important starting point for the implementation of energy control functions. On the one hand this market can make an important and substantial contribution to energy saving because of its size; on the other, it is likely that the majority of SMEs are willing to invest in energy-saving technology. It is therefore advisable to foster SME awareness for this aspect of facility management and to initiate limited pilot project on the regional level. A more general energy management would also allow including all kind of production processes and allow a more efficient (not only energy efficient) production of goods by using information for specific benchmarks.

Improved management of renewable energy loads: An example for successful economic policy is the successful expansion of energy generation from renewable sources. Based on realistic scenarios, however, this development cannot continue to rise without consequences for grid operation. If part of the success is not to vanish in grid congestions, overloads and control losses, it seems indispensable to use the potentials of ICTs here as well. Projects should be launched which deal with future grid management technologies for monitoring and controlling many different local suppliers in a single grid.

Construction and incorporation of virtual power stations: The development of virtual power stations in which small, decentralized production units are linked via ICTs can be advanced still further. It should be examined which technologies and systems can make a contribution to constructing virtual power plants, how their connections to the grid can be automated and whether incentives for corresponding business models should be installed.

Creating empirical data on home automation: Since especially private households have to be convinced of the potential of ICT based systems for energy efficiency, it is essential to elaborate a strategy as to how the penetration of home automation can be encouraged and existing investment and acceptance barriers overcome, bearing in mind possible rebound effects. Any implementation will require reliable data about (a) private households' knowledge about home automation, (b) the perception of risks and opportunities of home automation, (c) alternative, possible less expensive solutions, (d) the willingness of citizens to pay for certain functions, (e) customers' information and support needs, etc. The generation of relevant data is also seen as an important step towards home automation and more energy efficiency.

Involving relevant organisations dealing with consumer and data protection: consumer and data protection at the level of private households are issues that should not be underestimated. By involving the relevant institutions into the process early on, adequate solutions should be developed that preserve consumers interests while enabling systems for energy efficiency to develop.

Reducing or controlling rebound effects: there is potentially a role for policy making in encouraging the use of more efficient ICTs to minimise rebound effects. Concrete proposals would require further analysis of the issue, which is beyond the scope of this ETU.

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ACRONYMS / GLOSSARY

Acronym/ Term	Description
AMR	Automated Meter Reading
CHP	Combined heat and power
CRT	Cathode Ray Tube
DSL	Digital Subscriber Line
DSM	Demand Side Management
DVD	Digital Versatile Disc
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
PLC	Power Line Communications
PV	Photovoltaic
UMTS	Universal Mobile Telecommunications System
VCR	Videocassette Recorder
VPP	Virtual Power Plant

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EMERGING TREND UPDATE 4
ICT tools and services in intelligent domestic and personal environments

EPIS Work Package 1 – Deliverable 1.4 ETU4

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** The ETEPS AISBL – European techno-economic policy support network was set up on the initiative of the IPTS in 2005 by 19 effective members from 15 EU Member States. It further counts 19 associated members worldwide and is supported by a network of external organisations. Its main mission is to provide intellectual services for carrying out techno-economic and policy-related studies in the context of EU policy-making. See www.eteps.net for further information.*

EXECUTIVE SUMMARY

ICTs make it possible to increasingly provide tools and services that answer the needs of users in their personal and domestic environment. The term "intelligent domestic and personal environment" is closely related to the concept of smart homes and ambient intelligence, i.e. buildings equipped with computing technologies to answer users' needs.

The early vision of ambient intelligence (AmI) has contributed to the development of technologies that improve the quality of life of users, the efficiency of domestic tasks, increase security or well-being, and support special needs such as health concerns for an ageing population. While technological advances have sometimes been slower than expected, it is important to investigate whether there is a strong business case for intelligent environments.

At the same time research in the field of intelligent environments seems to be shifting from the strong technology focus it has had in the past towards understanding better user needs and users' interaction with the environment. Socio and economic implications also matter from a social science perspective, as these technologies affect people, their personal spaces, the artefacts and equipment around them, and the combination of these in terms of time and space.

Four layers can be distinguished in the various attempts to develop intelligent domestic and personal environments: homes containing intelligent objects; homes containing intelligent, communicating objects; adaptive homes (i.e. registering activity patterns of the users to anticipate needs) and attentive homes (i.e. activity and location of users registered constantly for even greater anticipation). In any case, there are functions that determine how people live in an intelligent home environment or what people can do in such environments. This paper focuses on the following five:

Home automation

Home automation refers primarily to the added-value of controlling existing functions like HPAC (Heating, piping, air conditioning), burglar alarms, electric appliances but also more sophisticated ones which are starting to emerge, based on users' preferences (e.g. automatic switching of specific music, degree of light). With increasing energy costs, home automation is starting to become attractive to home owners, although significant investments are still required, which are even higher in the case of old houses that need retrofitting.

Leisure & entertainment

Convergence is the main driver for ambient intelligence leisure devices and services, with home-entertainment oriented devices that dynamically connect with the environment and other devices. Key features include context-aware hardware and software, always on connectivity and portability. Augmented devices have recently appeared as opposed to completely new devices, and user generated content has not yet penetrated the home entertainment equipment realm. Beyond entertainment as the mere consumption of content, intelligent environments can become proactive and interact with users through sensors so as to support or stimulate certain activities (e.g. physical exercises).

Safety and security

This refers to the protection of physical access to the home, the safety aspect of the construction itself and the security of the technology and service infrastructure behind the intelligent environment. Generally to satisfy security concerns, intelligent environments should cope with failure along principles of graceful degradation, be self disclosing and respect the integrity of the user. Sophisticated locking systems or security solutions have to be non intrusive, intelligent and adaptable to changing contexts and spaces. RFID and biometrics are likely to contribute to new services and tools in that area. As to the infrastructure, a major challenge is authentication which goes against the non-intrusiveness feature of intelligent systems. Possible future developments include the emergence of "attribute authentication" systems. However users' fear of data misuse or fraud is a likely obstacle to the wide acceptance and diffusion of such systems.

Healthcare services

Smart technologies contribute to support independent living for ageing people, allowing them to stay in their homes while benefiting from e.g. versatile alarm systems or health monitoring systems that guarantee their safety. In a context of growing ageing population market opportunities for such systems are likely to increase.

Rest and relaxation

There has been little research on intelligent environments for better sleeping experience although some visions include air, light and temperature control systems or even more pleasant waking up experience. Applications can be devised for the various phases of sleep or the different spaces where sleep may take place (e.g. in bed, on a balcony or on the couch). In addition hygiene is also the object of intelligent environment developments such as integrating functionalities in bathroom mirrors.

In light of the above, it remains to be seen whether any of these markets will deliver their promises. Market data is very scarce, mainly because applications in the personal and domestic environment are still prototypes and large scale markets have failed to develop yet. An added difficulty is the lacking delineation of markets within the intelligent environment space.

The home automation market seems to be poised for the greatest growth rates according to Frost and Sullivan, although important constraints remain including the level of investment required. On a general level, demographics (ageing), greater need for security (e.g. terrorism) and global warming and its impact on energy savings may trigger demand for home automation. At a global market level, the distinction between niche markets and generic markets will persist, whereby it seems unlikely that mass market will develop any time soon. Last but not least some new players - especially the consumer electronic manufacturers - seem to have established strategies aimed at selling smart appliances directly to household consumers.

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1. INTRODUCTION

Intelligent environments promised to deliver multiple benefits to users facilitating domestic tasks and improving their quality of life. However these failed to materialise in practice as a result of technological but also socio-economic barriers. In view of the many potential benefits the development of intelligent environments may deliver, including in terms of growth and jobs for Europe, the subject is worth further study.

An intelligent environment, with a technological network surrounding those inhabiting it, will be able to:

- Recognise users and their circumstances (activities, state of mind, etc.) and operate consequently, i.e., be sensitive to human presence.
- Have a predictive behaviour based on knowledge of the environment (context awareness), of the habits of those who it is "serving" and of the specific activities of the same when acting.
- In real time, offer new services in fields such as entertainment, security, health, housework, the work environment, access to information, computing, communications, etc., with the aim of improving the quality of life of users.
- Allow access to as many services and features as it can carry out, regardless of where the user is located, of the position from where the user demands said services and the artefacts available at that particular moment (ubiquity).
- Relate, in a natural manner, to the users by means of multi-modal voice-based interfaces; by reading movements and gestures; by generating, emitting and projecting images; by generating holograms, etc. (natural relationship).

The vision of intelligent environments – or ambient intelligence - has captured the interest of industry, researchers and governments equally over the past years. Technological roadmaps have been developed, as have scenarios on how intelligent devices could be embedded in social life.[230] Much seems possible technologically, and we are aware of the social implications and pitfalls these technologies may raise, for instance in terms of trust, privacy and new social practices.[231]

However, it is still not clear whether intelligent environments can lead to viable business cases. Several questions need to be raised in this respect, starting from the user end of the story:

- Do we really need this? Are users really willing to pay for intelligent environments?
- Who can provide the corresponding services? What business models can be devised to make intelligent services work?

[230] The most prominent scenarios are the ISTAG scenarios: IST Advisory Group; Ducatel, K.; Bogdanowicz, M. et al. (2001). Scenarios for Ambient Intelligence in 2010. EUR 19763 EN. Luxembourg: Office for Official Publications of the European Communities.

[231] See for instance Wright, D.; Gutwirth, S.; Friedewald, M. et al. (Eds.) (2008): Safeguards in a World of Ambient Intelligence. Dordrecht: Springer (International Library of Ethics, Law, and Technology 1); Daskala, B.; Maghiros, I. (2007). D1gital Territ0ries: Towards the protection of public and private space in a digital and Ambient Intelligence environment Scientific and Technical Research series EUR 22765EN. Luxembourg: Office for Official Publications of the European Communities; Casert, R. (2004). Workshop Ambient Intelligence: In the service of Man? Societal aspects of ambient intelligence in the field of health and surveillance. RP-DIV-167. The Hague: Rathenau Institute.

- How significant is this likely to become?
- What role and importance do European actors (industry, service providers, etc.) play on both European and global markets?

These kinds of questions can only be answered by those who are exploring possibilities to commercialise products and services for intelligent environments. Guided by these questions, a number of short exploratory case studies of products and service solutions for intelligent domestic and personal environments have been collected. The case studies come from areas such as health, security, entertainment and leisure, rest and relaxation.

2. ICT TOOLS AND SERVICES IN INTELLIGENT DOMESTIC AND PERSONAL ENVIRONMENTS

2.1 DOMESTIC AND PERSONAL ENVIRONMENTS

The term “intelligent domestic and personal environments” is used to indicate the convergence of mainly two strands of development, namely the rather old quest for the development of smart homes with the vision of ubiquitous computing or ambient intelligence.

Such an environment can be defined as a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, trying to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond.

During the last few years the scientific literature in the housing field has become more diversified as concerns the topic of intelligent buildings and homes. The term "intelligent" has become somewhat outmoded or obsolete, being replaced by new approaches such as "aware house", "integrated environments" or "alive and interactive environments". Authors have diverted their interest in studying more the interaction between home and residents and related interfaces than technologies as "intelligent" in their own right. This change appears analogous to the shift of emphasis from techno-centred artificial intelligence towards human-centred ambient intelligence, ubiquitous intelligence/computing or versatile intelligence/computing.

The main trends driving the application of ambient intelligence technologies in housing can be identified as:

- acceleration of rhythm of everyday life, hectic and busy lifestyles, growing demand for efficiency and flexibility in daily routines,
- breaking up of the boundaries of time and space (increasing tele-presence),
- ageing of population, leading to a demand of elderly living longer in their homes,
- increasing demand of security and safety (e.g. due to rising crime rates),
- growing pressures to curb environmental problems and to save energy (to promote sustainable development and to compensate high prices of energy),
- increasing search for experiences and meanings (leading to building homes as media/entertainment centres),[232]
- increasing need for home as a sanctuary (home as dedicated to privacy, rest and relaxation)
- “technological” way of life i.e. lifestyles that take technologies for granted.

As Castells has pointed out in his classic study on the networked society "home centeredness" is an important trend of the new society. People increasingly work and manage services from their home. Home itself is expected to provide a safe haven of

[232] Cf. Rifkin, J. (2000): The age of access: The new culture of hypercapitalism, where all of life is a paid-for experience. New York: J.P. Tarcher, Putnam; Jensen, R. (1999): The dream society: how the coming shift from information to imagination will transform your business. New York: McGraw-Hill.

communication and caring, rest, relaxation and entertainment. Paradoxically, home can be characterised as being "wired" in order to "unwire" (relax) its occupants.[233] However, as Eggen et al. point out “the home is a feeling: it’s a cosy, trusted, and safe place, a place to return to, where you can be yourself and do what you want, where your own things are and where you meet people you love and like”.[234] As a result people have mixed feelings about a smart home: First and foremost intelligent domestic and home environments should provide convenience, comfort and luxury. They should also help to overcome drawbacks of current houses by taking over unwanted tasks. At the same time there are worries about cold and emotionless technological solutions that people cannot trust and that they do not control. In return people expect intelligent homes to be like an assistant giving advice, creating the right conditions and supporting the family members in their activities.

Among the various approaches to developing intelligent domestic and personal environments four different layers can be distinguished:[235]

1) *Homes which contain intelligent objects* – homes contain single, stand-alone appliances and objects which function in an intelligent manner
2) *Homes containing intelligent, communicating objects* – homes contain appliances and objects which function intelligently in their own rights and which also exchange information between one another to increase functionality.
3) *Adaptive homes* – patterns of activity in the homes are recorded and the accumulated data are used to anticipate users’ needs and control the technology accordingly.[236]
4) *Attentive homes* – the activity and location of people and objects within the homes are constantly registered, this information is used to control technology in anticipation of the occupants needs.[237]

With ubiquitous computing and communication technology the concept has moved closer to realisation. Although the gap between reality and vision is still wide, it is important that we start to give proper consideration to the implication this technology holds for the way we will live in our homes in the future.

To date the limited amount of research that has been carried out on this topic has primarily focused on technical possibilities. However from a social science and policy point of view it seems necessary to look deeper into the social and economic implications of smart home technology, mainly because home is quintessentially a “human” place with all the intricacies that this entails.

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[233] Castells, M. (1996): The rise of the network society. Oxford: Blackwell (The information age: Economy, Society and Culture, 1), pp. 397ff.

[234] Eggen, B.; Kyffin, S. (2005): Experience Design. In: Aarts, E.; Encarnacao, J. L. (Eds.): True Visions: The Emergence of Ambient Intelligence. Berlin, Heidelberg: Springer, pp. 359-376.

[235] Aldrich, F. K. (2003): Smart homes: Past present and future. In: Harper, R. (Ed.): Inside the Smart Home. London: Springer, pp. 17-40.

[236] Cf. Mozer, M. C. (2005): Lessons from an adaptive house. In: Cook, D.; Das, R. (Eds.): Smart environments: Technologies, protocols, and applications. Hoboken: Wiley & Sons, pp. 273-294.

[237] Cf. Abowd, G. D.; Bobick, I.; Essa, E. et al. (2002): The Aware Home: Developing Technologies for Successful Aging. In: Haigh, K. (Ed.): Automation as Caregiver: The Role of Intelligent Technology in Elder Care. Papers from the AAAI Workshop. Menlo Park: Association for the Advancement of Artificial Intelligence (Technical Report, WS-02-02), pp. 1-7.

Domestic technology has been referred to as “Cinderella” technology[238] and it simply does not stimulate the creativity of male technology designers. Homes are still maintained largely as women’s unpaid work but women have long been excluded from the development of the domestic technology they use, playing little or no part in the design process, at most they are viewed as passive consumers. It would be an oversimplification to see the whole neglect of domestic technology in male vs. female terms but there is an element of truth in that view.

In fact research into domestic technology provides great opportunities to support people’s lifestyles and improve their quality of life since in the developed world nearly everyone is a stakeholder because the home is such an important place.[239] Technology in a domestic and personal environment is concerned with people, spaces, rooms, artefacts, furniture, equipment, milieus and their various combinations in terms of time and space. There are functions that determine how people live in an intelligent home environment or what people can do in such environments. This paper focuses on the following five which are developed in the next sections:

- Home automation,
- Leisure and entertainment services (for example television, film and music),
- Safety and security services (for example alarms),
- Healthcare and well-being services, and
- Rest and relaxation supporting services.

The functions regulated and controlled by home automation are elements and functions of the house itself and its critical "living conditions" (housing infrastructure) as a basis for humans living in the house. They create the prerequisites for living in dwellings. Further functions developed in this paper are more centred on the residents themselves. They represent the functions people undertake more directly for themselves. In home automation the house itself is the major agent providing heating, lighting etc, while people moderate and control these functions. As regards other functions, people are major agents, while the house with its ambient intelligence provides optimal context for such activities. All the functions share as a common feature the purpose of responding to the users' needs and preferences in housing.

None of these services (including the related devices) are new inventions; they have all been available for a long time. The smart aspect is the integrated communication between these devices, and the possibility to generate automatic actions that can be used to provide new or improved services.

2.2 HOME AUTOMATION

Home automation has a long history but has failed to fulfil the great expectations of its promoters yet. The automation of certain functions in the domestic environment, however, will be the basis for more sophisticated functions and services. The main idea is to bring added value to the user by making the control of existing functions

[238] Cockburn, C. (1997): Domestic technologies: Cinderella and the engineers. In: Womens Studies International Forum, Vol. 20, No. 3, pp. 361-371

[239] Intille, S. S. (2002): Designing a Home of the Future. In: IEEE Pervasive Computing 1, No. 2, pp. 80-86.

like HPAC (heating, piping and air conditioning), fire and burglary alarms, control of electronic appliances easier, integrated and / or even automated. Most of the functions of home automation systems exist currently without any intelligence. Home automation technology in the past did not offer enough benefits for the house owners and end users that would justify the significant investments it requires. This may change with future "ambient intelligence"- enabled solutions. Here ambient intelligence means that the home automation system identifies the resident and adjusts these functions according to the known preferences. The favourite kind of music or TV channel is automatically turned on, a certain degree of lighting and heating is put on, window shades are adjusted etc. A major challenge in this respect is to decide on whose preferences the functions are chosen in a shared space when more than one person is present. Even in the case of a single person different contexts may require intelligent systems in different ways.

In the first instance intelligent systems enable functions for controlling the physical environment e.g. functions related to HPAC and security that have been part of the smart home vision for long. These functions should fulfil very high criteria for reliability and fault tolerance. The comfort of use is important but only secondary to these criteria. Hence, systems must be designed so that e.g. home server failures do not cause uncontrolled functions on these systems.[240] For instance, sudden turning off the lights in a cramped room may result in panic and accidents.

In the light of increasing energy costs home automation is starting to reach a significant market potential, especially since it is obvious to house owners and end users that intelligent HPAC functions lead to more efficient energy use and direct financial savings. Many industrial players in Europe direct their efforts in this direction; their guiding principles are rather different from the Ambient Intelligence vision promoted by the Philips or the European Commission.[241] However, even in the field of energy saving home-automation there is evidence that installations are not cost-efficient. New buildings equipped with smart building technology right from the start are in most cases already very energy-efficient. The investment needed to retrofit older buildings that have a higher potential for energy-saving are (at least currently) too high to be cost-effective. Experts from the building industry even expect that retrofitting will remain a very narrow market.[242] In the case of lighting the issue of energy saving can be addressed with the shift to more energy-efficient light sources like LEDs than with the use of intelligent switching.[243]

240 Rentto, K.; Korhonen, I.; Väätänen, A. et al. (2003): Users' Preferences for Ubiquitous Computing Applications at Home. In: Aarts, E.; Collier, R. et al. (Hrsg.): Ambient Intelligence: Proceedings of the First European Symposium, EUSAI 2003 Veldhoven, The Netherlands, November 3-4, 2003. Springer: Berlin, Heidelberg (Lecture Notes in Computer Science, 2875), pp. 384-393.

241 See for instance the German Programme "ICT 2020"

242 Pragnell, M.; Spence, L.; Moore, R. (2000). The market potential for Smart Homes. York: Joseph Rowntree Foundation.

243 Cf. Kraft, A. (2002): Einsparpotenziale bei der Energieversorgung von Wohngebäuden durch Informationstechnologien. Jülich: Forschungszentrum Jülich.

Examples of services and tools being developed

Major manufacturers such as Bosch/Siemens (serve@Home), Miele (Miele@home), Fagor Electrodomésticos (Maior-Domo) or V-ZUG (ZUG-home) have developed networked household appliances, based on power-line or wireless as communication medium.[244] These devices are already available on the market. In most cases the system design is based on a central computer that controls the various devices and is connected to the Internet. Although these devices have not become mainstream they have occupied a continuously growing niche market. Since household appliances have a rather high durability experts expect that networked household appliances will become commodities within 10 to 15 years. With a greater diffusion it will also become more interesting to provide additional services supporting domestic work and lifestyle.

2.3 Leisure and entertainment services – Sharing Content and Experience

The convergence of consumer electronics and IT is the most important technological trend towards ambient intelligence leisure and entertainment devices and services. This development can be considered almost completed, marking the blurring of the boundaries between media centres and multimedia PCs. The demand for more sophisticated home entertainment pushed powerful graphics into both consumer electronics and PCs and paved the way for information technology in the living room (e.g. Sony's Playstation Portable PSP, Apple's iPod and Intel's Personal Server). The latter brought along additional features and tore down protectionist walls (sometimes illegally, cf. content piracy, because the content industry reacted late and not always adequately).

All new popular entertainment devices have "plug-in capabilities" which points to the interconnected nature of future home entertainment environments. Instead of dedicated hardware and content media with their own business model, we will see home entertainment-oriented devices that will also be used for other purposes, and dynamically connected with various other devices and the environment. Experience has shown that especially the "misuse" of devices for new and unforeseen purposes may lead to disruptive innovations and totally new services.[245] There is no reason why this should not happen with next generation home entertainment devices. Major features and consequences are (1) new business models emerge: e.g., devices and services can be offered for users on the move, less profitable areas can benefit from hardware and features "cross-subsidised" from other application domains; (2) context aware hard- and software can be offered across domains; (3) whenever network connectivity is available/affordable, added functionality can be provided; (4) portability and business models have mutual influence and will trigger applications across traditional domains.

Current developments – especially when embedded in the smart home vision as in the case of Philips – lead to augmented devices that do not go beyond the traditional understanding of the user as a consumer of content.[246] The emperor's new clothes are

244 http://www.miele-at-home.de; http://www.bosch.at/content/language1/html/715_3529.htm; http://www.fagorelectronica.com/trata/domogestor.html; http://www.zughome.ch
245 Hippel, E. v. (2005): Democratizing innovation. Cambridge, Mass. and London: The MIT Press
246 See for instance Philips' ambient intelligence manifesto: Aarts, E.; Marzano, S. (Eds.) (2003): The New

called “shared experience” which only means that bigger screens and more realistic audio transform the living room into a home cinema. However, in the context of home entertainment technology and smart homes there is no evidence that actors from industry have adopted the idea of user-generated content (UGC) by providing consumer electronic products that are able to support the creativity of end users and offer interfaces for its distribution. The tools for user content production still come mainly from the Open Source/Free Software communities. This will probably change with the acquisition of important UGC platforms by major ICT and media companies.

Examples of services and tools being developed

- Philips has developed a common language for describing experiences within an Ambient Intelligence environment, the Physical Markup Language (PML). With a PML-enabled system, a room could reflect in real time the book someone is reading or the movie he or she is watching. Almost any device can be PML-enabled: lights could get brighter or dimmer, or change colour; the hi-fi would provide an appropriate soundscape, etc. With its „Ambilight products“ Philips has introduced first consumer product that embody the idea behind PML. For instance the premium class TV „Aurea“ – on the market since September 2007 - has 126 power LEDs placed around the screen. They are used to extend the light and atmosphere of the image outside the screen in a soft kaleidoscope of colours and make viewing a more intensive experience. However, with a price tag of more than 4.000 EUR it is far from being a product for the mass-market.[247]
- In 2003 Stefano Marzano of Philips together with high-end furniture manufacturer Felicerossi designed „Q4 Plugged“, a couch designed with the connected home in mind. It allows its owner to create a wide variety of polyfunctional 'zones' for relaxation and socialising. Q4 Plugged is fully 'wired' and can be fitted with a variety of electrical devices. The four basic elements of the couch can be linked together not only physically but also electrically. The 'buttons' in the mattress tops are actually elasticated holes, into which the various elements can be 'plugged' to position them and to make the necessary electrical connections. The armrests are hollow and equipped with a music player, a control panel and loudspeakers. It also includes a projector (for ceiling or wall projection), a web pad (screen and charging base), and a 'table lamp' using light-emitting polymers. Though the design received a lot attention the concept has not been picked up by other manufacturers yet.[248]

There are other ideas included in the Philips vision of ambient experience. For example, devices turning home into a home theatre with sophisticated sound effects and possibly composing aids could support music making at home. Voice recognition could be combined with databases so that the dwellers can turn on the music simply by humming a few bars of a song.[249] If literature is your favourite hobby, details of the novel you are reading could be retrieved via Internet and displayed on the wall screen alongside with some video clips of the author.

Proactive intelligent environments cannot only be used for improving user task efficiency. Sensors in these environments can detect and interpret bodily activity and can give multimedia feedback to invite, stimulate, guide and advise on bodily activity that can be used to improve physical and mental health (well-being) through exercise and through play and just for fun. Technically supported physical exercises may be related to a profession (ballet, etc.), some kind of recreation (juggling, etc.), or sports

Everyday: Views on Ambient Intelligence. Rotterdam: Uitgeverij 010 Publishers.

[247] Password: Philips Research Technology Magazine, Issue 23, May 2005. http://www.research.philips.com/password/archive/22/index.html; http://www.golem.de/0708/54456.html

[248] Cf. Bantle, F. (2003): Internationale Möbelmesse 2003: High-Tech in der Sofalandschaft. In: Deutsches Ärzteblatt 100, No. 1-2, p. A-52.

[249] Peterson, K. E. (2002). Home Sweet Ambient Home, from Philips: Forget the 'Smart' Home, This One Belongs to Mensa. http://www.10meters.com/homelab1.html

(fencing, etc.). Physical body movements may be the aim of other leisure related activities like dancing or gaming.

Such an intelligent home environment must be attentive, aware of the user needs, but not always aim for the most efficient solution and thereby denying the inhabitants a possible experience. That is, the ambient intelligent home environment should sometimes act as a dance partner.

At the borderline to health and well being applications are many ideas related to the monitoring of vital parameters during sportive activities. The related applications can play the role of a teacher supporting the user in acquiring physical skills, a coach advising the user how to achieve a higher level of physical performance or as a training partner giving encouragement and support.

Example of services and tools being developed

- The successful **Nintendo Wii** video game console is an example for the desire of consumers for a more natural interaction style in gaming. Though the wireless controller (Wii Remote) is still not very different from traditional joysticks it allows users to control the game using physical gestures.[250] Studies indicate that (physical) Wii gaming has an effect on users' fitness (both in positive and negative way).[251] Nintendo is very successful with a business model that includes the sale of hardware and software as well as providing a platform for online gaming and social networking between Wii users.

2.4 Safety and Security

Within the Maslowian theory of human motivation, safety (security, protection) is the second human need to be satisfied, just after the basic physiological needs (food, water, shelter). Security of the persons and goods is becoming in all the developed countries one of the major concerns and one of major divers of ICT products and technologies.

In domestic and personal environments security incorporates at least two central dimensions: (a) applications and services directly aiming at the improvement of the security situation of the user (e.g., entrance controls, alarms etc.) and (b) applications and services safeguarding the intelligent infrastructures being used in the home environments (firewalls, back-up systems, data security systems etc.); these security mechanisms also protect the user (and his/her data…)

According to these dimensions security in the domestic environment can be divided into several functions controlled through home automation:

- Security in terms of physical access control and burglary alarm systems,
- security in terms of safe construction (and materials), monitoring and control of the "health" of the building;[252] this can also be seen as part of the basic functions supportive functions as depicted in the previous section, and

250 http://wii.com/

251 Lanningham-Foster, L.; Jensen, T. B.; Foster, R. C. et al. (2006): Energy Expenditure of Sedentary Screen Time Compared With Active Screen Time for Children. In: Pediatrics 118, No. 6, pp. e1831-e1835; Acute Wiitis. (2007): In: New England Journal of Medicine 356, Nr. 23, S. 2431-2432.

252 Snoonian, D. (2003): Smart Buildings. In: IEEE Spectrum 40, No. 8, pp. 18-23.

- security of the technical and service infrastructure of the intelligent system itself, thus protecting the intelligent home's functions, its users and the integrity of the users' data (mainly via secure access control mechanisms and intrusion protection systems such as firewalls etc.).

These functions are mostly based on the application of ICTs for maintaining various alarms (for the prevention of theft and accidental events caused by the elderly, disabled, children, pets etc.) and protection systems (to prevent unwanted manipulation of the technical systems etc.).

Of course, health protection related issues, such as health monitoring devices and intelligent alarm systems in emergency situations, are also important fields for ongoing R&D. However, due to the overlap with the application area of supporting independent living and personal wellbeing, health related security issues are dealt with in section 5.

Physical Access Control and Alarms

Generally, without considering basic security issues, intelligent environments will be rife with vulnerabilities; intelligent environments impose new and additional requirements on security. The demand for sophisticated locking systems to secure physical access to the domestic environment is growing in parallel with the rate of burgling in most, if not all, developed countries. Moreover locks capable of identifying persons and permitting hands-free opening would be useful for several population groups: elderly, children and disabled, as well as parents entering home with both hands carrying shopping bags and guiding several children along. The next generation of locks will thus use electronic keys such as magnetic cards, RFID tokens or biometrics or the combination of some of the above.

Such security solutions have to be non-intrusive, intelligent *and* able to adapt to rapidly changing contexts of the space. Smart home environments require proper and adequate security measures to prevent unauthorised access and enforce security policies.[253]

Another approach that should become affordable for private homes within five years or so is biometric access control, such as fingerprint and iris scan, while face recognition still needs maturing.[254] Voice recognition offers natural interaction at the cost of lower security. The main challenges for biometric methods today are their insufficient usability and public acceptance.[255]

[253] Al-Muhtadi, J.; Ranganathan, A.; Campbell, R. H.; Mickunas, M. D. (2003): Cerberus: A Context-Aware Security Scheme for Smart Spaces. In: Proceedings of the First IEEE International Conference on Pervasive Computing and Communications (PerCom'03), March 23-26, 2003, Fort Worth, Texas, USA. Los Alamitos: IEEE Computer Society, pp. 489ff.

[254] See for instance Bundeskriminalamt (German Federal Criminal Police Office) (2007). Face regocnition as a search tool (Foto-Fahndung). Final report. Wiesbaden. http://www.bka.de/kriminalwissenschaften/fotofahndung/pdf/fotofahndung_final_report.pdf.

[255] Chellappa, R.; Phillips, P. J.; Reynolds, D., eds. (2006): [Special Issue on Biometrics: Algorithms and Applications]. In: Proceedings of the IEEE 94, Nr. 11, S. 1912-2044; Maghiros, I.; Punie, Y.; Delaitre, S. et al. (2005). Biometrics at the Frontiers: Assessing the Impact on Society. Technical Report EUR 21585 EN. Seville: Institute for Prospective Technological Studies (IPTS). http://www.jrc.es/home/pages/detail.cfm?prs=1235

Examples of services being developed:

- IBM Pervasive Computing Lab: "You can increase the level of security in the home by enabling remote monitoring, and power management of lighting in the front of the house."[256]
- Home security: alarms in case of unauthorised intrusion etc.

  – electronic door locks ensure that the inhabitants do not forget to lock the door; each person living in the house has his/her own key, which can easily be replaced if it is lost. In addition, people inside can receive information about who is coming and who is leaving the house.

  – simulation of physical presence: if the inhabitants of a house are away, their presence can be simulated by the intelligent house system.

  – alarm in case of burglary: if an intruder is detected, the intelligent house responds with turning the lights on and off etc. In addition, outside cameras – equipped with motion detectors – monitor the situation around the house. The video footage can also be transmitted to the owners (via the home server)

  These kinds of security applications and services are already available commercially.[257]

Security of the technical and service infrastructure of AmI and information security

A major problem with traditional authentication and access control methods is that they need a high level of user activity – which clearly runs against the ambient intelligence vision of non-intrusiveness. Moreover, the increased digitisation of our assets, coupled with the increasingly intangible way ubiquitous networks use information, will make ensuring trustworthiness of trusted services difficult.[258] Traditional identity authentication is not suitable for the pervasive paradigm, as fundamental security parameters in intelligent environments will change:

- interaction takes place between devices, and it is very difficult to reliably determine the identity of arbitrary devices and arbitrary environments
- and simply proving the identity is not very helpful because this fact provides little assurance of what the device will actually do.

Therefore, Creese et al. (2005) propose to introduce systems of "attribute authentication": any device will have a range of attributes such as its location, name, aspects of its current state, functions etc. Within AmI and the increasing pervasiveness of information services, the authors argue, both the range and the heterogeneity of the problem space will increase. And in order to be able to design appropriate systems of "attribute authentication", a broad range of issues referring to the user level, the service level and the infrastructure level respectively need to be better understood.

Other, rather near-to-market security solutions being proposed are based on DRM systems. DRM safeguard personal data and aim to ensure that the applications being used are not tampered with and provide a safe environment.[259]

256 http://www.ibm.com/developerworks/wireless/library/wi-pvc/

257 For instance ABB, SSS Siedle; Siemens, Philips, Honeywell and others are members of the initiative "Intelligent Housing" organised by the German industry association ZVEI. See http://www.intelligenteswohnen.com/

258 cf. Creese, S.; Goldsmith, M.; Roscoe, B.; Zakiuddin, I. (2005): Research Directions for Trust and Security in Human-Centric Computing. In: Robinson, P.; Vogt, H. et al. (Eds.): Privacy, Security and Trust within the Context of Pervasive Computing. Dordrecht: Springer (The Springer International Series in Engineering and Computer Science, 780), pp. 83-91.

259 Hohl, A.; Zugenmaier, A. (2005): Safeguarding Personal Data with DRM in Pervasive Computing. In:

The above-mentioned approaches to improving the security of the intelligent environment infrastructures and the level of information security do not only apply to home environments, but also to many other contexts in which intelligent systems will unfold. The common concern of the researchers working in this field is the firm conviction that users' fears about misuse of data, the lack of security and the risk of fraud will seriously inhibit the broad acceptance and diffusion of intelligent personal and domestic services and technologies.

At a more general level, security concerns can be addressed by applying important basic principles according to which future systems and architectures should be designed:[260]

- In case of system failures, functionalities should be lost progressively, not all at once. However, in intelligent environments, the principle of "graceful degradation" is insufficient. Applications and services should be designed as to ensure the users' physical, psychic and financial safety.
- Moreover, intelligent services and applications should always be self-disclosing. The user should be automatically notified about the presence of information collecting and transmitting systems. Thus, the services should contain provisions for immediate and transparent querying of their capabilities, use and ownership. An important step on the way to reaching the goal of transparent self-disclosure might be the development of a vocabulary of graphic icons that inform the user about the environment and its status, the data being collected etc.
- Intelligent systems should also be designed in such a manner as to prevent the embarrassment or the humiliation of users in the course of normal operations. Of course, this principle applies a rather broad understanding of "security" which includes the issues of information privacy and the value of self-determination as integral elements of an individual's subjective sense of feeling secure.

Finally it should be emphasised that what actually constitutes "security" for the user is both contingent and culture-dependent.

2.5 Healthcare services and support of independent living

In Europe there is a long history of building institutions for people in need of medical, practical or emotional care. The trend changed during the 1990s, supported by political incentives like grants and cheap loans to the local authorities. This plan of action led to a massive increase in the building of residential apartments, thereby enabling people to stay in private homes, instead of having to move to an institution when their need for care increased. It is unknown how many of them are actually equipped with smart home technology.

The first and foremost impact on independent living is the principal opportunity to live in your own home, and not in an institution. "Independent living" requires a suitable home in accessible surroundings, access to appropriate personal assistance,

Robinson, P.; Vogt, H. et al. (Eds.): Privacy, Security and Trust within the Context of Pervasive Computing. Berlin: Springer Verlag (The Kluwer International Series in Engineering and Computer Science, 780), pp. 147-156.

[260] Cf. Greenfield, A. (2006): Everyware : the dawning age of ubiquitous computing. Berkeley, CA: New Riders.

technical aids, medical care, a secure financial position, transport, constructive leisure activities and family and friends providing support and enrichment.

Apartments for elderly and disadvantaged people are homes, not institutions. This is an important distinction, as laws and regulations controlling the economic and public goods depend on the type of ownership to your dwelling. In an apartment, the resident pays the rent and is for example entitled to technical aids from the state. In an institution the clients pay for "bed and breakfast", and the owner of the institution supplies the necessary technical aids.

The ownership may make a big difference, not only to the resident and his family, but also to the person's self-esteem and dignity as well as to staff, depending on whether one speaks of a premise provider and a client or a patient. One could even argue that it might have an influence upon health, providing we define health in a wider sense than absence of illness.

Safety is the biggest advantage of smart home technology. The resident, their family or their carers can feel safe due to the versatility of the alarm systems. There are a number of ways to operate the alarm system, having programmed it to the individuals needs. The user himself may trigger the alarm like an ordinary call alarm. It may also be activated by the system, without the user being aware of it as 'passive alarms'. The alarm may be activated when something irregular occurs, or when a normal action fails to happen.

So far, smart home technology has been introduced as a support to safe and independent living, not as compensation to the human carer.[261]

Smart home environments may support independent living out of institution, and it seems that this might be good economy for society. The person may continue to live in his own technological upgraded apartment, this makes him more independent for a longer time, and he and his relatives feel confident. Should his need for smart functions change or increase, he already has the network installed, and can add more executing devices and services, or alter the setup of the installations.

By 2020 50% of the population in Europe will be 50+, and in many countries there will not be enough personnel to take care of them in a decent way. We have for example already seen how smart home technology may cause fewer general routine visits of the community-based team. Some persons may welcome having fewer visits, whilst others may find it isolating.

[261] For a rough assessment of market potential see http://www.aal-deutschland.de/marktpotenziale

Examples of services being developed:

- Health monitoring:
  – Philips has developed wireless sensor networks that monitor patients' vital signs; because the sensors are wireless, the user can move freely throughout the home. The difference to existing devices is: Philips technology monitors in real time and can notify the emergency services if needed.[262]
  – Another system to increase security in the health area: identification technique to make sure that patients are getting the right dose of medication (also at home).
  – home case patients can be monitored based on their usage of lighting, water or the frequency of opening and closing doors. If some of these parameters differ significantly from the norm, the caretaker is informed.
- Information Needs of Parents for Pervasive Awareness Systems:[263] With regard to Awareness systems in domestic environments, "automatic capture" systems are the avenue developers are following: awareness information is gathered through context sensing and interpretation.These so-called "Ambient Awareness systems" are a class of communication systems that support awareness between individuals or groups of people. First explorations of this concept have been conducted with regard to parents with children. For the use in home environments, research labs are developing systems that display the general availability of individuals for communications. The added value of these rather calm technologies: creating low-effort links between people.
- IBM Pervasive Computing Lab: Additional commercial applications mentioned with security aspects: child monitoring, pacemaker monitoring, stay-at-home monitoring, real-time monitoring when a patient is discharged from hospital. All these applications interact with the server side of the system.[264]

2.6 REST AND RELAXATION

Sleeping can be considered as the most important form of the function of resting. People also spend about a quarter of the day in bed. Quite little has been done in order to enhance the sleeping experience by means of technologies of ambient intelligence yet.

Visions include "smart" system controlling air conditioning, lights and temperature in the bedroom making rest more relaxing. There is also a possible need for ambient intelligence applications providing more pleasant ways of waking up.

Accordingly, the applications of ambient intelligence supporting sleeping can be focused on the process of sleep in its initial, midterm and final phase, embedded in clock, bed, lamp, window, floor etc. They can also be concentrated on connections inside the house, giving signals to other people in the house of sleeping persons in order to avoid disturbance. Besides sleeping, there are various degrees of rest such as drowsing. It can also be done in other rooms than the bedroom alone – lying on the couch in front of TV may be one of the most popular places to take a nap. The

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262 Password: Philips Research Technology Magazine, Issue 23, May 2005. http://www.research.philips.com/password/archive/23/index.html

263 cf. Khan, V.-J.; Markopoulos, P.; Mota, S. et al. (2006): Intra-family communication needs: How can awareness systems provide support? In: Kameas, A. D.; Papalexopoulos, D. (Eds.): Proceedings of the 2nd IET International Conference on Intelligent Environments (IE 06), 5-6 July 2006, Athens. Stevenage: IET Press, Vol. 2, pp. 89-94.

264 http://www.ibm.com/developerworks/wireless/library/wi-pvc/

weather permitting, resting can be situated on balconies, terraces or in the garden. The function of resting may be supported by ambient intelligence applications such as sensors embedded into the furniture measuring the resident's pulse, blood pressure and suggesting different kinds of electronic massage or acupuncture. Such massaging armchairs have already been in the market for consumers for at least two decades. However, intelligence could be added in the form of (bio)sensors, identifying the person sitting and his or her wishes.

Another function closely related to rest and relaxation is concerned with the basic needs of the residents to refresh themselves and take care of their hygiene at home. This is an area where consumer electronics already abound. Here, ambient intelligence could be added to this array in the not-so-long-future. Bathing and showering space (tube, shower, sauna) could be equipped with ambient intelligence to identify the user and set the initial temperature of water, for instance, and play the background music expected. Tooth brushing, combing, shaving, making-up etc. normally takes place in the bathroom in front of the mirror.

Example of services and tools being developed:

- With „Nebula“[265] Philips Design has developed the prototype of an interactive projection system designed to enrich the experience of going to bed, sleeping and waking up. It provides intuitive and natural ways of physically participating in a virtual experience, through simple body movements and gestures. The aim was to create an atmosphere that encourages and enhances rest, reflection, conversation, intimacy, imagination and play. Nebula consists of a ceiling projector linked via the Internet to a database of content. Once users have selected the content for projection, they can manipulate it by adjusting their sleeping positions and interacting with their partner while in bed. Since the dynamics between individuals are random and unpredictable, the flow of content created by the couple will be unique and specific to them. In general, the ceiling projection becomes livelier as the participants become more active. The type (topic, theme) of content is selected by placing a smart 'pebble' into the bedside pocket. For example, a 'cloud' pebble produces content related to clouds and the sky, while a 'poem' pebble produces content related to poetry and rhymes. The Nebula system also provides functions like an “intelligent“ alarm clock, messaging and gaming.
- Philips also explores the possibilities to elevate the current standards in a bathroom by integrating AmI technology to enhance the overall experience for the user. One of the most prominent elements in a washroom is the mirror. By incorporating the functionality of displaying useful information, such as temperature, weather forecast, date, time, and news headlines, the user should find their time spent in the washroom more worthwhile („Smart Mirror“). Using sensory equipment this idea can be expanded to using the mirror for personal and health care, such as the shaver initiating an assistant, showing the right shaving pressure to use. A scale, displaying the weight in the mirror, can also activate the health coach informing the user about the cardiovascular state of health and give advice on improvement, also based on measurements from the activity monitor and heart rate sensor.[266]

There is little evidence that development activities have resulted in marketable products yet. One reason is an ongoing debate about the effect of electromagnetic fields (electromagnetic pollution) on the human. Part of this discussion is the

265 http://www.design.philips.com/about/design/portfolio/researchprojects/smartconnections/nebula/
266 Password: Philips Research Technology Magazine, Issue 22, February 2005. http://www.research.philips.com/password/archive/22/index.html

unresolved question of possible impacts of electromagnetic fields on human sleep.[267] This is a serious barrier for consumer acceptance that is has not been addressed by industry yet.

2.7 MARKET DEVELOPMENT

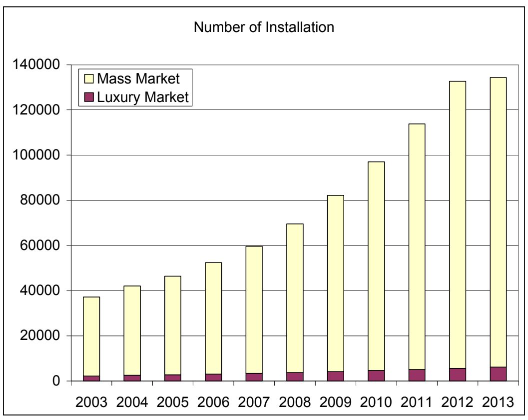
Some Market data

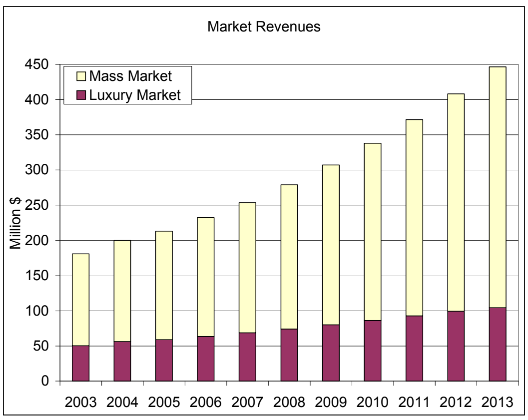
It is difficult to grasp the size of the market for ICT tools and services in intelligent domestic and personal environments in concrete figures. This is mainly due to the fact that many of the more visionary applications and services exists as prototypes or pioneering products at best. Neither is there anything like an agreed delineation of the respective market.

What can and has been estimated is the market for more conventional smart home technologies (see section II.2). Frost & Sullivan have published studies on "European Home Automation Markets" in 2000, 2003 and 2007 respectively.[268] For the purpose of these studies home automation system was defined by its ability to control at least two applications within the home (Climate Control, Lighting, Audio Visual Presentation, Security, Communication Networks, Automated Barriers, etc.). In their assessment they state that the market is divided into two segments. The luxury segment is characterised by large numbers of customised touch screen display interfaces, installed in luxury apartments, villas and mansions. The mass-market segment is characterised by more affordable systems for the average household.

Frost & Sullivan estimates that the number of installations – while still being low compared to the number of accommodation units – is growing with a rate of 10 per cent in the luxury segment and about 17% in the mass-market segment. Due to declining prices for individual installations the market revenues will grow a bit slower than the number of installations. The market researchers expect that revenues in Europe will grow from 180 million $ in 2003 to almost 450 million $ in 2013. While only 5 to 7 per cent of installations are in the luxury segment it produces some 25 per cent of the revenues and will thus an important and "playground" for innovative products.

Figure 10: Development of the European Home Automation Markets, 2003-2013





Source: Frost and Sullivan, 2007

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[267] http://www.emf-portal.de/index.php?l=e

[268] Frost & Sullivan (2007): European Home Automation Markets. Report M107-19. London

Although fundamentally optimistic Frost & Sullivan (like other researchers) see important restraints for the home automation market, in particular the total cost of installation, the limited retrofit installation and to a minor degree scepticism at important actor groups, lack of awareness and missing ease of use. On the drivers side they consider new building constructions and renovations in combination with a stronger prioritisation of the home and finally the potential for energy conservation.

As far as market players are concerned Frost & Sullivan state that home automation markets are fairly fragmented with the share of the top three suppliers summing up to only 36 per cent. The leading manufacturers in 2006 were Siemens, Schneider, Hager and Legrand in the mass-market segment and Crestron and AMX in the luxury segment. The United Kingdom and Germany (about 25% of the revenues each) are by far the strongest markets, followed by Spain, Italy and Benelux and France (about 10%).

SWOT analysis

In order to broaden the analysis of market developments and gather further evidence about the rationale for further studying intelligent environments, an analysis of the strengths, weaknesses, opportunities and threats (SWOT) has been carried out, taking account of the global context as well as socio-techno and economic drivers and barriers.

The following table summarises the SWOT findings for intelligent ICT solutions in the domestic and personal environment on the path toward commercialisation.

Table 6: SWOT analysis

Strengths • Intelligent ICT in domestic and personal environments can provide socially desirable benefits by addressing individual needs in a wide range of applications • European manufacturers are at the forefront of technological development – Pioneer advantage	**Weaknesses** • Retrofitting of existing housing very expensive • Technology push approach of main industry actors • No “killer application” visible today
Opportunities • Demographic change is paving the ground for technology supporting independent living • Higher security needs increases demand for intelligent solutions • Increasing energy costs may improve cost-benefit ratio of home automation • Development of new, individualised services	**Threats** • Lack of standards, interoperability and scalability of solutions restrain development of critical mass • Consumers are very sensible with regard to new domestic information and communication technologies (privacy, electromagnetic pollution)

Future opportunities in many areas start from the home environment where complete automation and control is possible, where devices can interact with each other seamlessly. These opportunities may be triggered by various social and economic developments such as demographic change (ageing), global terrorism and crime or, the higher perceived need for more security, as well as the need to save energy in a context of global warming and decreasing natural resources. These needs can all be addressed through the same basic technologies and can ideally be integrated into one system.

Nevertheless, earlier technological visions with similar goals were not successful due to weaknesses that persist today. One of those is the still prevailing technology-push approach of many industrial players who produce devices and applications that do not meet the real needs of consumers and often ignore their concerns about technologies that may intrude their personal sphere. More pragmatically the costs of equipping existing house with the necessary technology are still too high. Finally no market player has managed to develop an application that is so useful or desirable for the customer that it justifies high initial investment (i.e. a „killer application“). Factors that may impede the growth of this type of technology are mainly privacy, security and health concerns, as well as barriers to the realisation of network effects, such as lack of standards or interoperability.

Markets and players

The distinction between the "niche markets" and "generic markets" looks set to continue. Niche markets cater for the needs of special groups such as the elderly or disabled people. By definition, therefore, it is a smaller market but one with potential to take off rapidly if the cost saving benefits of providing health care and practical support through home technology can be established. Attempts to do so are underway.[269] The generic market targets the population as a whole and is therefore potentially a huge market in comparison. However, no smart home technology so far has had the "must have" quality which led to the rapid diffusion of e.g. televisions, with take-up largely independent of household income. Historically "time using" technologies have been adopted more swiftly than "time saving" technologies. This suggests that inroads into the generic smart home market are most likely to be made by technologies which address the perceived quality of discretionary time.

There is some indication that the main players in the commercial market for smart home technologies are changing. Historically, electrical equipment suppliers like Philips or manufacturers of switches, sockets and distribution boards have played the leading role in developing this market. Today, consumer electronics manufacturers such as Nokia, Sony and Panasonic have established strategies to market ranges of so-called "smart" appliances directly to household consumers.

[269] See for instance: Riva, G. (2003): Ambient Intelligence in Health Care. In: CyberPsychology and Behavior 6, No. 3, pp. 295-300; Mihailidis, A.; Elinas, P.; Gunn, D. et al. (2006): Pervasive Computing to Enable Mobility in Older Adults with Cognitive Impairment. In: UbiHealth 2006: The 4th International Workshop on Ubiquitous Computing for Pervasive Healthcare Applications, Irvine, 8 September 2006.

3. CONCLUSIONS

In general the future of ICT tools and services in the domestic and personal environment is promising, because it offers many desirable benefits and has the potential to trigger more user involvement and interaction. While these benefits have been recognised and communicated by important actors from industry, politics and other stakeholders, the implementation of *real* applications, their integration into everyday life and adaptation to daily practices (domestication) remains difficult.

In light of current trends in intelligent home environments the following elements seem to be the most important obstacles for diffusion:

- *Dependence on housing stock* – In Europe, the importance of old housing stock means that manufacturers must find solutions for retrofitting existing housing, which is more expensive than networking a home at the time it is built. There is little prospect that this will change. Experts from the building industry even expect that retrofitting will remain a very narrow market.
- *Lack of common protocols* – historically this has been one of the reasons why European industry tended to focus on simple on-off switching systems for single applications. This, however, is becoming less of an obstacle than previously because of the general trend towards a seamless networking and all-IP-networking.
- *High initial investments from the consumer* – cost remains relatively high restricting the market to the middle and upper income brackets, and potential buyers must first be convinced of benefits they will derive. A likely development is the evolution of a more modular system that people can acquire in stages and a variety of services the consumer can choose from. Currently, however, manufacturers seem to be more interested in fully fledged solutions, although often only for parts of the personal and home environment, and show little initiative to create open and modular systems that can be upgraded incrementally with components from any manufacturer.
- *Little usability evaluation by suppliers* – Suppliers have done little to evaluate the usability of their products. This is not a simple task, however, because of the diversity of the user population, variation of the context of use, prior training necessary, and the challenge of investigating products not yet in existence. Currently it seems unlikely that attitudes in this respect are about to change.
- *"Technology push" by suppliers* – Suppliers still follow a narrow "technology push" approach and pay too little attention to understanding the needs of users. This is also true for players like Philips who claim to be user and use-oriented.

  Consumers want systems and services that help them with managing everyday tasks and lead to labour saving and task simplification, ease of operation and cost reduction. There is a gap between consumer requirements and the products currently available. In particular suppliers need to win the acceptance of women, who still remain responsible for the bulk of the domestic tasks.
- *User values and habits* – Studies on user needs and the acceptance of different functions developed in technology-driven smart home projects came to the

conclusion that domestic technology remains a difficult business because people value people, space and memories a lot more than technology or physical possessions. These values are highly associated with feelings of comfort, relaxation and sentiment, while technology and automation are viewed as saving time rather than adding to personal values. An illustration of this perception is the fact that people see intruders as a greater hazard than gas or carbon monoxide poisoning and that consequently means to call for help are more valued than environmental monitoring.[270]

As a result developing smart home technologies for "easier markets" like industrial or office environments with the expectation that spill-over effects will occur when the technology matures and prices decrease seems unrealistic.

In conclusion, the above obstacles will have to be addressed for intelligent environments to develop in Europe, beyond the niche markets that already exist today. Putting users – male and female – at the centre of the design process will certainly help devise applications that gain users' acceptance although as long as high investments will be needed to build or retrofit a building into a smart home market uptake will be slow.

[270] Haines, V.; Mitchell, V.; Cooper, C.; Maguire, M. (2007): Probing user values in the home environment within a technology driven Smart Home project. In: Personal and Ubiquitous Computing 11, No. 5, pp. 349–359.

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Acronyms / Glossary

Acronym/ Term	Description
AmI	Ambient Intelligence
HPAC	Heating, piping and air conditioning
ICT	Information and Communication Technologies
LED	Light Emitting Diode
PML	Physical Markup Language
RFID	Radio Frequency Identification
RTI	Research Technology and Innovation
TV	Television

EMERGING TREND UPDATE 5

Privacy in the Knowledge Society – the Case of Search Engines

EPIS Work Package 1 – Deliverable 1.5 ETU5

Administrative Arrangement
30-CE- 0070769/00-29

IPTS – IS Unit

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** The ETEPS AISBL – European techno-economic policy support network was set up on the initiative of the IPTS in 2005 by 19 effective members from 15 EU Member States. It further counts 19 associated members worldwide and is supported by a network of external organisations. Its main mission is to provide intellectual services for carrying out techno-economic and policy-related studies in the context of EU policy-making. See www.eteps.net for further information.*

Executive Summary

1. Search engines (S-E) act as a gateway to the Information Society. These are in many cases the only means users have to access information and navigate among the wealth of data available. In doing so S-E collect data on users habits/desires in order to facilitate searching and make it more accurate. They have thus gathered a broad range of data which permits targeting users with commercially lucrative advertising, which has become the S-E main business model. The more information on their users the S-E collect the more lucrative for addressing marketers needs and therefore the more advertising revenue S-E may generate.

2. New services also emerge which use S-E technology to facilitate access to data that is manipulated without the original owner's consent or even awareness. Some of these services combine data on users' online behaviour with that of their off-line behaviour or combine data from mobile devices to jointly mine it. The limits of such practices are expanding since users seem to be willing to part with their data oblivious of the possible future complications while providers see in such practices a strong business model to monetise the otherwise 'Free' content distribution culture that has characterised the Internet since its very beginning.

3. The implications of the widespread proliferation of data, including that of personal sensitive nature or location-based data, logically raises concerns in our society about the privacy intrusive capacity of S-E. In particular one can question the legitimacy of S-E processing third-party data related to persons, the re-use of data that has been illegally 'extracted', the enrichment of data collected for one purpose with data that allows connecting it to physical people and/ or their location. In addition, as S-E dominate the advertising market, there are other issues relating to the impact their actions may have on trust in relation to users data that S-E store and use but also in relation to advertisers and publishers as to ad-space that is made available for commercialisation. Further privacy issues deal with privacy policies and their degree of implementation as well as the rules applied to sensitive data handling whether this relates to the foreseen retention period, their protection from loss or theft, the regulation that permits their handing-over to national authorities and their degree of anonymisation.

4. Overall data protection regulation covers S-E use, although the open issue of whether IP addresses are defined as personal data or not needs to be resolved. Moreover, it is recommended that everything possible be done to open the S-E market and make it possible for new entrants to survive. There are however, a number of emerging applications that generate new risks and further study is needed as to the possible implications of privacy abuse. In addition to adapting the legal framework, Privacy Enhancing Technologies (PETs) ought to be developed not only to limit S-E use but also to provide viable alternatives for anonymous searching. Market initiatives, like alignment of S-E privacy policy and self-regulation as to the implementation of such policy could also help.

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1. Introduction

1.1 The importance of search engines in the knowledge society

We are currently witnessing a trend of data explosion. In June 2005, the total number of Internet sites was believed to be in the order of 64 million, with two digit annual growth rates. The amount of information created, stored and replicated in 2006 was estimated to be about 161 billion gigabytes – equivalent to three million times the information in all books ever written. That figure is expected to reach 988 billion gigabytes by 2010.[271] This data explosion has been triggered by today's technological capacity to store, copy and distribute information at decreasing unit price.

This data comes in a variety of formats, while content has evolved far beyond pure text description and its use has become essential for our economy and society. In this environment of information overflow, the retrieval of relevant content has become a prime challenge. Therefore, search engines have become the main access mechanism to all kinds of publicly accessible information. Search engines have become gatekeepers and magnifying lenses of the internet; these facilitate access to the point that any obscure web content may become instantly famous or notorious. For instance a recent study[272] reveals that for the large majority of users requiring online travel services, they first query search engines and get relevant information by them before acceding to specialised web sites.

However, while online users are exploiting the possibilities offered by search engines (S-E) to access free content and to participate to a variety of new social networks for pleasure or business, they are leaving unwittingly digital traces of their likes and dislikes, habits and desires. While users enjoy the wealth of information they can access, some black clouds emerge; market players from the entertainment industry as an example are worried about the adverse consequences to their existing business models. Also individuals and consumer associations are more apprehensive of the need to protect their sensitive data which is flooding the web.

Given initial evidence of unauthorized data collection (e.g. without the owner's consent), authorities in charge of regulating and implementing data protection legislation are becoming more concerned. Although data protection legislation is applicable over all online services, the case of S-E is unique because of the importance for this key technology which – in a way – magnifies the potential advantages / disadvantages that data access implies. With data growing exponentially and an increasing number of distribution channels it is cumbersome to consider the possible implications for widespread privacy abuse or how to protect collected data.

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[271] *See* Andy McCue, Businesses face data 'explosion', *ZDNet*, 23rd May 2007, *at* http://news.zdnet.co.uk/itmanagement/0,1000000308,39287196,00.htm (last visited: 18th December, 2007), referring to IDC/EMC Study *The expanding Digital Universe*. The data explosion has been estimated also by other studies, such as the previous *"How Much Information"*, by Peter Lyman and Hal R. Varian (http://www.sims.berkeley.edu/how-much-info-2003)

[272] Study by Google and comScore into online consumer behaviour in the travel sector; http://www.comscore.com/press/release.asp?press=1991

In this ETU we present a selected number of cases of privacy abuse mainly in relation to S-E use so as to draw preliminary conclusions as to what can be done to mitigate risks in this arena.

1.2 Overview of privacy abuse in the knowledge society

1.2.1 Background to privacy intrusion on the Internet

Data on users is needed to facilitate the provision of online services; often it is collected to enable personalisation and thus offer a more adaptive service. Many end-users are willing to give away some personal data to benefit from new 'intelligent' services. For instance, when providing social networking sites with a lot of personal details that would enable them to find and socialise with other like-minded people. In some cases, however, data is collected and used to achieve objectives that are not related to the wishes of the end-user; often this occurs without users even being aware of this. Even worse, data thus used may be passed around to satisfy objectives that are even more distant from the original purpose of data collection, thus creating the perception of end-user surveillance for profit. A similar process is now being used by legitimate online businesses which collect all data possible in relation to the online behaviour of individuals and then process them to produce information as to their preferences; these may, in turn, be used to target them with commercially lucrative advertising.

Financial transactions usually require large scale databases belonging to credit card companies, banks, insurance companies, and brokerage firms. These all contain information with a potential to privacy intrusion as a result of Governments accessing it in their fight against crime or terrorism or even affiliate institutions sharing it in their struggle for competitive advantage. Similar data from insurance companies are being shared to risk-assess companies and individuals alike and this is another potential source for privacy abuse. Medical records are now widely well protected since they have been defined as sensitive personal data. The advantage of enabling private medical records access over the Internet is obvious but the potential for misuse is rather hefty as this type of data may be used for job interviews, calculation of insurance benefits as well as private crime like blackmail. Microsoft and the US Defence Department have agreed to jointly develop the medical data warehouse prototype HealthVault,[273] as well as the analytical tools needed to access health data and records, for the US Defence Department's massive clinical data repository.

Having briefly presented better known privacy infringing cases, a number of foreseeable but less well known privacy intrusive cases follow. These are cases that are not strictly related to search engine technology privacy risks; they are nevertheless interesting as they involve search engines and mobile devices and demonstrate how easy it is to extend the limits of possible future privacy threats. Such systems for example, demonstrate the trade-off between privacy concerns and convenience; they raise questions as to how to provide the world with an enforceable sense of privacy when governments, financial institutions, search engines, social networking sites and mobile phones are constantly logging life and sharing the collected results. This begs the re-assessment of technological, legal, social and other methods of protecting privacy.

[273] http://www.healthvault.com/

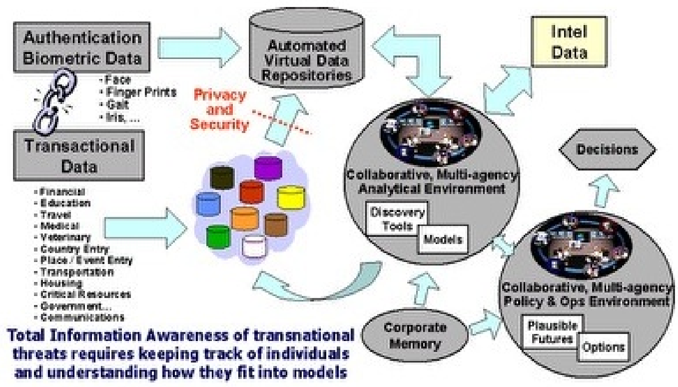
1.2.2 Combining location-based and social-networking data as a privacy risk

With emerging location-based services like Google's MyLocation, which enables the use of Google Maps geographical index technology on mobile devices, this situation will raise new implications for its potential privacy intrusion dimension. Location-based social networking is expected to become increasingly popular as more phones integrate satellite technology. This has additional privacy implications in cases like facilitating offenders to locate their victims in this way via mobile social networking sites.[274] Several companies are exploring such routes, like Bliin in the UK and Canadian-based Kakiloc while established social networks like MySpace and Facebook claim that they currently have no plans to integrate tracking systems in their services.

1.2.3 Reality Mining – a mixed blessing

Latest generation mobile phones may be regarded as environment sensors. For instance the Bluetooth function records your position in relation to other devices around you; microphones can analyze talk patterns (talk length, interruptions, tone of voice) interpreting someone's likely role in groups; and a future build-in accelerometer could detect whether you are sitting or walking. MIT Lab argues that the mobile phone : (i) may gather information to distinguish which of your Facebook friends are also your friends in real life; (ii) may help identify a health problem (e.g. epidemic) in 12 hours instead of two weeks by observing the behaviour of the people living in the same building; (iii) may measure the social health of communities (social integration, transparent political discussions, enabling community events and improving the liveability of the area); and (iv) also alert its owner about marketing and shopping opportunities.

In pace with the emergence of the above functions new opportunities appear for collecting much larger datasets on human behaviours. Mobile phones become the ideal vehicle to study both individuals and organizations as people usually carry mobile phones with them and use them as a medium for most of their communications while they also constitute a better data mining tool; mobile phones provide raw, unfiltered information, which ends up being more reliable than information reported by people themselves on their own behaviour, as the latter is subject to distortion. Reality Mining[275] defines the collection of machine-sensed environmental data pertaining to human social behaviour. This new paradigm of data mining makes possible the modelling of conversation context, proximity sensing, and time-spatial location throughout large communities of individuals. Moreover, the commercial value of reality mining is far too great to restrict its use to the academic world and the potential intrusions into personal privacy could prove dramatic.



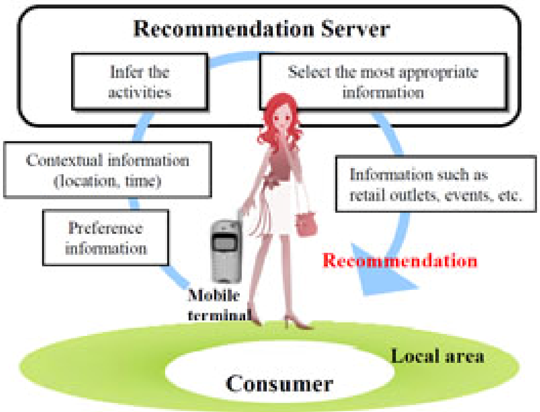
Total Information Awareness is all about the Reality Mining

[274] http://news.bbc.co.uk/1/hi/technology/6767593.stm

[275] MIT Media Lab's Human Design research group at http://reality.media.mit.edu/

1.2.4 Recommender systems – a mobile phone that tells you what to do

Mobile devices are increasingly used as information-gathering tools to browse websites and download content. Using contextual information, such as time of day or positional information obtained via a mobile GPS, software called Magitti[276] uses an exclusive algorithm to forecast, with a high probability of success, the kinds of "eating", "shopping", "seeing" and "playing" opportunities for consumers to enjoy in their vicinity. Magitti combines GPS data from a user's phone, text messages and information about events from the phone's calendar, and uploads it to a server, along with the user's search term. According to Technology Review[277] are confident that people will adopt these location-finding tools if benefits are significant for user, and there is trust in the system.



2. Cases of search engine-related privacy intrusion

2.1 The advertising business model of S-E and likely privacy abuse

There are more than 70 Search Engine (S-E) operating world-wide – Google, Yahoo and MSN being the major ones – of which Google is the dominant S-E and more so in the EU than in the USA. Google's overall market share is estimated at 61% with a low market share in China but more than 80% in EU countries. In spite of this, even Google is not capable of searching the "Deep Net" estimated to be 20-30% the size of the visible web.[278] The Google business model is advertising. In the past, search engines offered both traditional advertising services and innovative internet-based services. Traditional services include display advertising, like banners or buttons appearing on the search engine's page, or classified advertisements, like ads listings in a directory.

Today, search-specific advertising is dominant. When a query is introduced into a search engine, the user receives two results lists delivered. The first list, is a web search provided for free in a pull mode, whose ranking is by relevancy. The second is an advertising list whose ranking is auctioned. Search-specific advertisement is highly efficient, as the user informs the engine what he/she is looking for, unlike traditional advertisement, e.g. newspaper or TV. Pay-per-Click is the dominant revenue income for S-E, the advertiser pays according to the number of user clicks on the hyperlink of the sponsored list. The system provides an incentive

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[276] DNP(Dai Nippon Printing) & PARC (Palo Alto Research Center) recommender system at http://www.parc.com/about/pressroom/news/2007-09-26-dnp.html

[277] Sources: Technology Review, November 13, 2007

[278] http://library.lanl.gov/cgi-bin/getfile?LA-UR-05-9158.pdf

for publishers to target ads correctly as the payment does not depend on the ad being seen but on the viewer responding and following the hyperlink.

As more people search the web the S-E results become more relevant and that in turn make advertising through a S-E more appealing. It is no surprise then that strong S-E providers start to play a role in intermediating between advertisers and publishers across the web as the latter recognise that it is through these S-E providers that they may sell more ad-space. The trends towards adopting fully advertising-based business models is reinforced by the 2007 acquisitions by the three major search engines (Google, Yahoo! and MSN) of main online advertising businesses. New techniques like behavioural targeting, which is a method for analysing user behaviour in order to determine when a user is more receptive to ads, make user behaviour more predictable and correlate it with purchase decisions. The success of these techniques depends on the extent to which user behaviour can be tracked and the amount of user data that can be collected and monitored. The acquisition of online advertising companies (e.g. like Google merging with DoubleClick) extends the reach of the three search engine providers, while personalization of search processes helps users disclose more of their data. Personalised search techniques like social search or recommender systems can create ideal conditions for advertisers to reach their customers.[279]

The collection and commercial use of user data gives rise to privacy issues which have become an increasing concern for new web business models. Every time users visit web pages and carry out any type of transaction, they reveal important information about themselves: for example hints on sexual preferences, consumption behaviour, workplace, phase of life (marriage, birthday), financial situation and other private information. This situation really goes beyond individual people, since by making sense of the preferences of individuals one may also assess the direction a whole department may take – for example the research Unit of a business.

We live a paradox of privacy: on the one hand, people reveal their intimate thoughts and behaviours online in social networking and on the other hand, they are concerned that government agencies and marketers are collecting personal data and using it for security surveillance or profit. Examples are the "web beacons" like Facebook's Beacon, monitoring the surfing habits of users increasingly used by companies for advertising purposes.

[279] "Desperately seeking the consumer: Personalized search engines and the commercial exploitation of user data" by Theo Röhle, *First Monday,* volume 12, number 9 (September 2007), http://firstmonday.org/issues/issue12_9/rohle/index.html

Box 1: The Facebook Beacon case

Social networking sites have enjoyed exponential growth rates over the past years,[280] which makes them a fertile battleground for advertising purposes in particular. In September 2007, Facebook announced that it plans to make user profiles available to S-E such as Google.[281] When Facebook users shopped online, the Beacon software told businesses what they looked at or bought.[282] Concerns were raised that this move would represent a privacy risk,[283] referring to the fact that the data trails that people routinely leave behind will be aggregated for marketing or other purposes.

In November 2007, network members forced Facebook to change the Beacon advertising from an "opt out" system to an "opt in" system, i.e. it allows Facebook to track data only if consent of the user.[284] The Facebook apology highlights a debate surrounding privacy and advertising in the online space concerning the use of "web beacons" to monitor the surfing habits of users and to what use is made to that information by advertisers. Similar to Facebook's Beacon, Google's OpenSocial is planning to gather all of a person's social actions on the Web ('universal activity streams') and share them in a feed on Google or an OpenSocial partner site like MySpace or Bebo. These feeds could then appear in Gmail, iGoogle, or Google Reader. The universal activity stream is expected soon.[285]

Online advertising is the fastest-growing segment of the advertising industry, growing at an annual rate of 25%, or more than five times the recent average annual growth all media included.[286] It is estimated that around 7% of advertising is spent on the Internet globally. Internet giants including Google are keen to develop targeted advertising to boost revenues. However a balance has to be struck with privacy. Targeted online advertising is set to face increased scrutiny from EU regulators concerned by privacy invasion. Recommendations from the EU advisory body on data protection matters Article 29 Working Party (Art.29 WP) have been used by the European Commission to get Google to reduce the amount of time it stores past Web searches to 18 months.

Google's announced acquisition of DoubleClick is considered by BEUC, the EU's consumer association,[287] as harming European citizens through greater intrusion of privacy, as Google will use it to enhance its profiling capabilities. BEUC considers that this acquisition lays at the border between competition and consumer issues. The merger could eventually eliminate any competition and reinforce Google's dominant position in the search ads market allowing Google to obtain in non-search advertising the same unbeatable market position that it now enjoys in search advertising. In its position paper, Microsoft[288] points out that Google is effectively forcing its competitors to create viable alternative pipelines.[289]

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[280] European Commission IPTS research on socio-economic impacts of social computing (EroSc) - ¨Social Computing- hype or reality?¨ by C. Pascu, (forthcoming 2008)

[281] http://news.bbc.co.uk/1/hi/technology/6980454.stm

[282] Users were annoyed when the Facebook Beacon service unwittingly revealed Christmas shopping surprise

[283] Om Malik in his blog GigaOm

[284] http://news.bbc.co.uk/1/hi/technology/7120916.stm

[285] http://www.techcrunch.com/2007/12/19/google-poaching-beacon-partners-for-universal-activity-stream/

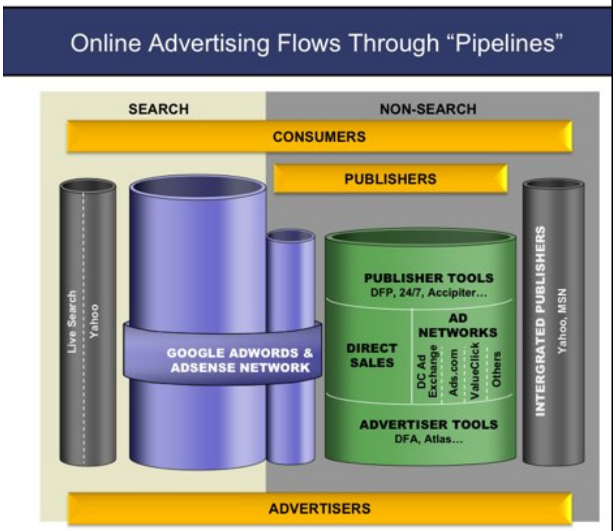
[286] http://www.freepress.net/news/28371

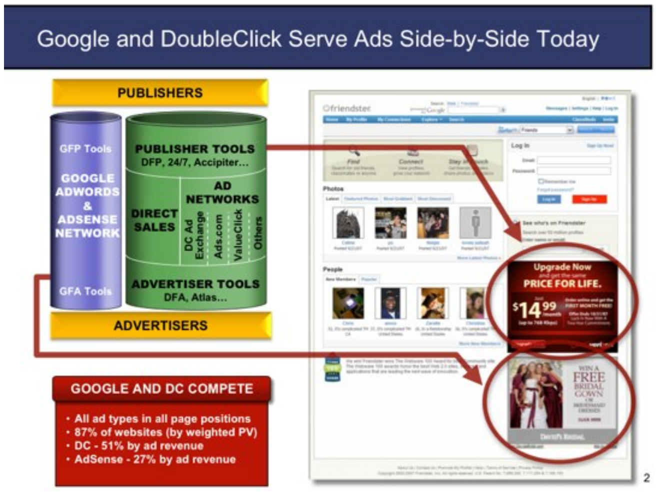
[287] http://docshare.beuc.org/docs/2/FBAEPEIACIPMBEPOEALAPDHFPDB39DWYTK9DW3571KM/BEUC/docs/DLS/2007-01174-01-E.pdf

[288] http://www.nytimes.com/packages/other/technology/bitsantitrust.doc

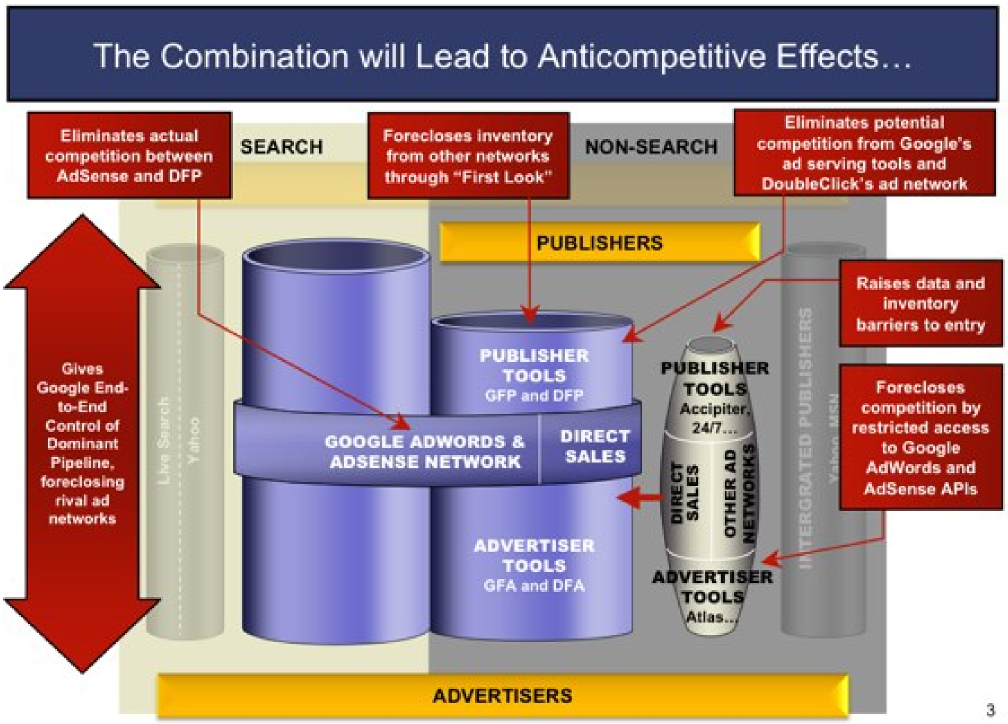
[289] "… by acquiring the dominant provider of ad-serving tools that publishers use to manage and make their inventory available to advertisers, Google will force other online ad networks to build and market their own ad-serving tools. Unless and until Google's competitors are able to obtain access to competitively neutral and unbiased ad-serving tools like those currently provided by DoubleClick, the ability of Google's rivals to

Box – Google/DoubleClick Merger Consequences





Description of how Google and DoubleClick were and are serving the market before and after their merger.



Source: Techcrunch[290]

create viable alternative pipelines will be very difficult, if possible at all. Moreover, by the time competitors are able to assemble their own pipelines, given the network economics that characterize online advertising, Google likely will have obtained in non-search advertising the same market position that it now enjoys in search advertising. "

[290] http://www.techcrunch.com/2007/12/26/eu-microsofts-last-stand-against-googles-acquisition-of-doubleclick/

The concentration of consumer data in one company raises concern of consumer rights as well privacy concerns. The merger would combine information about the consumers collected by Google's search engine with the tracking data provided by DoubleClick collected as users navigate the Net, hence permitting more intrusive tracking and user profiling. Google's monopoly will come at the expense of the consumer, who will face higher prices for the online services, less choice and lower quality of service. By entering into what media calls a "privacy race", BEUC considers that Google will loose incentives to innovate in the area of online privacy, thereby harming consumer welfare.

2.2 Legitimacy for S-E to process third-party user data in relation to persons

S-E also facilitate access to information on persons that are not necessarily voluntary users of the system, e.g. when the latter is obtained from third-party web sites. Recent cases raise questions about the legitimacy for disseminating and making accessible personal information on the web.[291] Legitimacy for processing could in principle lie with those enabling access to the information. People have to have the right to ask, at any time, to review the personal information collected; to have the information corrected if necessary; and to have the information removed from the search engine's history, depending on the exact circumstances. The Spanish Agency for Data Protection (AEPD) has been defining the criteria for protecting the right of cancellation of the information available on the Internet and, specifically, the appropriateness of the right of opposition with respect to S-E services.[292]

2.3 Protection needed against re-use of data lost

This is an issue that is indirectly related to S-E; the way S-E facilitate identifying and providing access to information is only exacerbating the problem incurred when stored data is 'lost' or 'stolen'. Usually, privacy relevant data loss events include large datasets with personal information. An example of this is the data related to almost 40 million accounts affecting various credit-card brands apparently 'stolen' from credit-card processor CardSystems Solutions.[293] In another similar example in the UK in 2007, two crucial CDs containing the personal details of 25 million child benefit recipients including their names, national insurance numbers and bank details have gone missing. Almost inevitably when data is lost it tends to reappear with an increased value as it is usually combined with earlier lost information so that there is an increasing probability of abuse of all data lost. The wave of data loss in businesses and government agencies makes the need for reviewing privacy legislation more pressing than ever

2.4 Threats from S-E combining data from many sources including location data

An example of a questionable use is Google Maps' Streetview feature that enables taking detailed images of or inside everyone's homes. In May 2007, Google Map's introduced Streetview allowing for 360-degree panoramic views of various streets in cities around the US. Such images were made public without the 'owners' conesent or awareness when a Wired magazine blog asked its readers to vote for the “Best Urban Images” from among a set that other readers identified using the Google StreetView feature; a picture of two young women

[291] "Google tendra que olvidar tu pasado" by M. Belaza at http://www.elpais.com/articulo/sociedad/Google/tendra/olvidar/pasado/elpepisoc/20080122elpepisoc_1/Tes

[292] https://www.agpd.es/upload/Canal_Documentacion/Recomendaciones/declaracion_aepd_buscadores_en.pdf

[293] May 22, 2005 MasterCard International in the USA http://www.securityfocus.com/news/11219

sunbathing in their bikinis on the Stanford campus in Palo Alto ranked near the top. Despite these concerns, Google stated that "the imagery taken on public property is no different from what any person can readily capture or see walking down the street" and the feature is part of its mission to "organize the world's information and to make it universally accessible and useful". However, this raises questions as to the balance between the concepts of free speech, open information, and the idea of privacy.

2.5 OTA services and emerging threats

Classical wiretapping is not a new activity; what is new however, is that companies like Google have better data sets and tools to manipulate public opinion. Digital wiretapping of wireless communications has been extended to Internet Service providers, who can offer additional services in the form of location tracking and "over-the-air" (OTA) updates and social Networking sites such as Facebook, Xing, Twitter, Jaiku., Flickr, and Youtube, which are able to make personal background checks by combining data available on the web from different sources. It is obvious that in the above case there is privacy intrusion potential; what makes this case different is that OTA updates enable a mobile phone network provider to perform silent software installations on remote terminals thus facilitating extended surveillance.

3. Implications

There is ongoing discussion in the EU Member States as to whether existing legislation protects the privacy of individual users sufficiently (Data Protection Authorities and Art.29 group). The Data retention legislation in Member States complicates things since data is, by law, kept even longer and is thus subject to potential abuse for longer. Moreover, tackling privacy issues in the search engine area is inevitably more complicated since the international scope of search engine operations cannot be regulated by national laws.

We think that loss of data will increase and so will the business models that rely on the merging of data from various information sources, whether they were acquired legally or illegally, to construct added-value information, opening up a new dimension for an internationally operating data trade market. Whether this affects copyright law or media law, security and privacy rules or specific regulation for telecommunications operators and/or broadcasters still remains to be seen. End-users will also have to be educated to understand the risks of the Information Society better and be prepared to protect themselves, from relatively innocuous contextualized advertising practices to severe privacy infringing practices that could lead to identity cloning and theft.

We will analyse a number of priority issues below:

3.1 Trust issues in relation to search engines

When discussing privacy implications of the extensive use of S-E, one has to consider the implications on the 'trust' to the environment of search. Users are dependent on the use of S-E as this is their preferred way of finding what they want on the web, as they are unable to keep up with the multitude of new applications, interesting sites and content awareness services. They are happy they can find information related to what they are searching and as such they are willing to forego their right to judge the information they receive and thus have an opinion as to whether to trust the source or not.

The non-adequate differentiation between ranked and sponsored results among the results served by S-E was a recognized problem of the early times of internet search. Although since then S-E have made an effort to make this difference more visible, still many users seem not to understand the difference between advertisement (sponsored list) and search results looked for. It would be worthwhile investigating if in this way knowledge shrinks over time and which measures could be taken to remedy this situation.

Moreover, when considering the position of business and their need to be well placed in a relevant search process, it is well known that there have been abusive cases of page rank manipulation (e.g. related to the Google S-E, the case of BMW.de,[294] SearchKing.com[295]). In these cases S-E tend to penalise sites when they detect that the standard optimisation guidelines are not followed; however, it is not clear how much S-E operators are using these rules in a way to 'persuade' commercial sites to buy into their advertising programs.

Overall the risk that the environment created by the use of S-E requires 'trust' building measures both on the end-user side as well as on the advertising client side if S-E are to be used as main access points to the Information Society as a whole.

3.2 Privacy issues in relation to Search Engines

While all S-E providers abide to the data protection and Privacy legal framework in operation in their country of establishment, they all have own privacy policies. Sometimes these privacy policies do not enforce privacy rights in the same way in all countries. This enables some countries to establish exceptions when allowing S-E operations within their jurisdiction such as is the case of China or S. Arabia. In addition, in the case of Google their own declared privacy policy had to be modified after the Online Privacy Protection Act of California was enforced in 2004; in practice Google had to change their main privacy policy as experts stated that the "previous version sidestepped important issues and might have been illegal". Also, in this new privacy policy, Google make clear that they will be pooling all the information they collect on their users from their various services but it is not so clear how long this information will be retained (unless a cookie has not been activated the last 24 months). Google is in a position to keep it indefinitely, and give this information to third parties without specifying who this might be.[296] Other service providers have similar policies.

Google's privacy policy claims that they do not collect identifiable information from their users. However, as many users now have static IP numbers and as Governments exercise their right to obtain the information in Google's (and other search engines') possession, there is concern that the authorities will be able to access this information in a relatively easy way. Moreover, the fact that Google records unique cookie ID, IP number, date and time, makes much of this information "identifiable". In this case authorities may also do a "sneak and peek" search of Google users hard drive when they are not at home, and retrieve a Google cookie ID, which they may use to get a keyword search history from Google for this ID. An issue in relation to the protection of end-user privacy by S-E that would need to be addressed through appropriate legal measures (at least at EU level) is whether an IP address is personally identifying information.

[294] http://news.bbc.co.uk/2/hi/technology/4685750.stm
[295] http://www.pandia.com/sw-2003/21-searchking.html
[296] Google-Watch: http://www.google-watch.org/krane.html

Another issue relates to the web2.0 trend of user-generated content and freely available metadata to help web site indexing and therefore improving S-E results for the benefit of the end-user primarily but also preventing click-fraud and thus for the benefit of the business client as well. In this case there is a conflict since the same data is almost certainly going to be used to enhance the S-E ability to target end-users with organic results and focused advertising. Finally there is another issue that relates to S-E quest to become privacy-friendly labelled by adopting globally respected data protection standards and thus imposing a new need for oversight and enforcement of the privacy policy of the S-E.

On the brighter side, there is in almost every S-E privacy policy a clause in relation to the protection of minors against racism and pornography which is widely respected. In conclusion, while S-E are subject to privacy and data protection laws there is still need for further oversight of the implementation of the specific privacy policies as watch groups claim that these represent 'a rosy and unrealistic picture' of the extent to which they protect the privacy of the S-E user.

The Legal situation in Germany[297] *and the EU in relation to Search Engines*
Research is ongoing as to what protection is being offered in Member States and on what legal grounds certain web services are infringing privacy. There is also very little scientific judicial literature on this topic and almost no test processes by the data protection agencies. A few examples in relation to German and EU law will be presented below in an effort to improve understanding over the existence of legal gaps:

a. Overall jurisdiction of data protection

In most privacy issues it matters where the client, not the server, is located; the Telemedia Law (TMG) states that if a service provider is located within the EU the laws of the country of origin have to be applied while if the service provider is located outside the EU, the principle of territory is applicable, meaning that a German user using a US internet provider or S-E is protected by German law and does not have to seek protection at US courts.

b. Human Dignity and profiling

Both, the German Federal Constitutional Court and Art.8 of the European Convention for Human Rights and the EU Data Protection Directive rule that the compilation of partial or nearly complete personal profiles on the basis of available data was not compatible with human dignity. Especially, in those cases when the person concerned is not able to control the correctness and completeness of this profile. This however is exactly what can be done with internet services such as Spock.com or with any query entered into S-E.

c. Information about persons

Storing and retrieving information about persons would require the explicit agreement of these persons in the case that they themselves did not upload this information to the net in the first place according to the Data Protection law. According to the same law, S-E that enable search on persons are generally illegal; nonetheless this happens. Thus, the degree of illegality depends on the degree to which the person concerned can influence this data exposure and the degree of transparency that is granted to him/her concerning the collectors of the information. Any person also has to have the right to object to, correct, choose and delete data related to his/her person. None of these rights, though, are sufficiently granted or enforced on the internet. Moreover, as

[297] Germany considered a Member State with an impressive Data Protection Legislation

cached web pages can be stored for a long time it can take years until false information is deleted or corrected. And in most cases the S-E providers react only if a legal document is presented that requires them to do so. According to the law not only the service provider who is uploading information is responsible for the status of such information but also the service provider who makes the search of such information possible (‘second publisher’).The same law protects citizens who for legitimate reasons should not have their personal information disclosed. S-E however, rank search results according to use criteria and not according to the “legitimate interests” of the person searched for.

d. Unsolicited and personalised advertising

Data Protection Law provides the right to objection in case of unsolicited advertisement by any person whose data are collected and then made available on the net through S-E. This includes objection for the purpose of market research and opinion polls as well. This law has been getting more importance since the Google merger with DoubleClick and the linking of search queries with contextualized advertisements. Thus, according to this law, the kind of ad links that pop up with any search queries is illegal if we as users object. It is also illegal (German Telemedia Law) to link user profiles (including the ones based on cookie-based IP addressing) to user generated data with the objective to target them with contextualised or personalised advertising.

e. Data retention

Data retention laws compel internet service providers and telecommunication companies to collect/retain customers’ data.[298] The European “Data Retention Directive” (March 2006) requires the storage of non-content data, such as subscriber information, traffic and location data and legislates that S-E providers are responsible to control storage time of user information. On the one hand advocates of data protection demand the deletion of cookies and all sorts of personal user information as soon as possible and reject any storage of such information;[299] on the other hand new laws require the retention of a customer’s data between six months and two years.[300] Art.6 of the Communication Privacy Directive prohibits the storage of traffic data without user consent once the data are no longer required for the actual transmission of a communication or for billing purposes. Some experts pointed out that the EU “Data Retention Directive” might not apply to S-E and user search logs since they argue that it is not clear if companies such as Google when acting as a S-E (and not for example in the case of Gmail) provide “electronic communications services”, in which case it would be required to maintain traffic data under Art.3 of the “Data Retention Directive”. One can also argue that a search query may be regarded as communication contents, which is not subject to retention under the new legislation.[301] This service can be conducted within three days which is the storage time after which some S-E (such as yasni.de) delete their users' IP addresses. The Art.29 Working Party claimed that storage periods of 18 to 24 months are excessive and unnecessary from the point

[298] To our knowledge data retention legislation is not as crucial in the U.S. European telecom companies have to abide to much stricter data protection laws, whereas U.S. S-E providers usually store their user’s traffic data for commercial exploitation without being legally required to do so. (Omer Tene 2007, p. 64)

[299] User search logs need be immediately deleted. In their resolution of 2006 the Art.29 Working Party suggested that after a search session no data should be stored that can be linked to an individual user unless this user has given his/her consent (28th International Data Protection and Privacy Commissioners’ Conference, London, UK, Resolution on Privacy Protection and Search Engines (Nov. 2-3, 2006).

[300] depending on the laws of each member state

[301] (Omer Tene 2007, pp.66-67

of view of the user and Google responded by shortening the retention period to 18 months. At the same time Art.29 WP pointed out that in case some Member States preferred a longer retention period local S-E would have to comply.

3.3 Other legal concerns in relation to search engines

There are a number of other issues that raise legal concerns on the relations between content owners and S-E. Copyright law is responsible to solve conflicts of interest between creators and users/distributors (e.g. S-E operators). A first type of problem relates to the right to store and temporarily reproduce content; as is the case of web crawlers finding and storing information even after the permission to reproduce has long expired. This case also places emphasis on the right to ask that S-E 'forget'. At the same time a number of exceptions to copyright are not valid in the case of S-E, thus making it more difficult to provide content through S-E, in a lawful way (copyright law may prevent indexing, caching, etc…). This problem is building new barriers to the free/open access to content by new intermediaries. Moreover, as content providers may desire to bring more attention to their content they may be in a position to negotiate not suing S-E for copyright infringement but to make exclusive indexing agreements which in turn may prove to be sub-optimal for End-users.

Other issues regard the relationship of advertisers with S-E and most notably the implementation of trademark law. A number of cases fought last year in court on both sides of the Atlantic show a diverging interpretation of trademark law by EU and US competent authorities in relation to unfair competition and comparative advertising. The legal response will inevitably trigger a different approach in S-E advertising techniques and positively or negatively up-take of new business models and thus influence growth and job creation.

3.4 International initiatives on S-E privacy protection

In view of the importance of the above presented situation there are a number of initiatives that are already taking place some of which we will briefly present below:

1. Research

In May 2005, the French-German Council of Ministers initiated the project Quaero. At first it was funded by French and German public money and an industry consortium of the two countries. Different perceptions of what goals are to be pursued with Quaero, however led to the split-up of the two teams, the Germans also starting an initiative of their own called Theseus.[302] A new S-E called Exalead,[303] which is operating in the enterprise search arena, is a noteworthy result of the Quaero initiative. Exalead claims to have as many web pages as Google – even though it really competes with S-E like Autonomy or FAST. There are other research initiatives that are going on but it is clear that more coordination of research in this area is needed as well as more research in Audio-Visual search mechanisms.

2. Art.29 Data Protection Working Group

Art.29 Data Protection Working Party is an EU independent privacy advisory group. The Art.29 Working Party suggested criteria for making data retention requirements more amenable to privacy rights without getting into conflict with the new retention laws. The

[302] http://theseus-programme.de
[303] http://www.exalead.com

Working Party suggested that data retention be limited to narrowly tailored purposes, such as fighting terrorism and organized crime. It suggested that there must be no further processing of retained data by law enforcement authorities for related proceedings, and do access to the data by additional government or non-government entities. It requested that prevention of terrorism not include large-scale data mining schemes; that access to data be duly authorized on a case by case basis by a judicial authority; and that systems for storage of data for law enforcement purposes be separated from systems used for business purposes. (Art.29 WP Opinion 4/2005). Among many other activities, the group is watching Google. An Art.29 Data Protection Working Group investigation in the summer of 2007 prompted Google's chief privacy officer Fleischer to publicly explain why search logs are stored such a long time. He argued that Google was constantly improving its services to the users and its security as well. It was therefore necessary to know the contexts of the various searches since a single query may have different intentions e.g. complicated by the use of homonyms. According to Fleischer, historical log information is maintained as it can help detect and prevent phishing, spam and other undesired attacks. Though these activities by Google will hardly raise any concern there is widespread suspicion that Google stores and analyses user search log and search histories to optimize its core business: placing ads. Especially with the acquisition of DoubleClick contextual advertising has gained a new dimension in the web business: It means that users retrieve in addition to their search results also advertisements that match the context or content of the search. It thus comes as no surprise that S-E providers such as Google are hesitant to delete log files immediately after a search session is finished.

3. EPIC case on the Google-DoubleClick merger

Another example for the importance of public watch is the open discussion raised by the U.S. pressure group EPIC (Electronic Privacy Information Center) on the Google-DoubleClick merger. EPIC and other pressure groups in the U.S. filed a complaint with the U.S. Federal Trade Commission, requesting that the Commission open an investigation into Google's acquisition of DoubleClick. Of special concern was the ability of Google to record, analyze, track, and profile the activities of internet users with the data that is both personally identifiable and data that is not personally identifiable. A hearing was held upon this request attaining a lot of public attention. Even though the Federal Trade Commission had no objection to the merger, now the European Commission Directorate on Competition has announced a four-months in-depth investigation into the merger. Investigation starts end of January 2008. EPIC will be one of the expert groups invited to testify.[304]

[304] http://epic.org/privacy/ftc/google/ download: Jan. 10, 2008.

4. Conclusions

With our society becoming increasingly dependent on information that is collected, stored and distributed online and search engines becoming the preferred access mechanism to this wealth of information, it is no wonder that privacy and trust issues related to S-E are high on the policy makers' agenda. In addition, the limits of such practices are expanding since on the one hand users seem to be willing to part with their data oblivious of the possible future complications this may imply and providers see in them a strong business model to monetise the otherwise "free" content distribution culture that has characterised the Internet since its beginning. A number of real and likely privacy intrusions that relate to the actual practice of commercially operating S-E have been briefly presented in the first part of this ETU. In addition, a number of issues raised by S-E mechanisms acting as a bridge to personal data that are manipulated through non-S-E privacy infringing mechanisms have also been identified.

An analysis of the implications of such trust and privacy intrusive activities has brought in evidence a number of issues mainly of legal but also of technological and social nature. The need to reconcile convenience of use of 'intelligent' services with safeguarding the sea of data that is needed to support the services is evidently an issue of concern. The need to revisit existing privacy protecting legislation to improve our understanding of what issues need be addressed at what level (making best use of self-regulatory measures) is another point that needs to be addressed. Also, issues in relation to S-E operation that need be addressed are:

(a) the legitimacy of S-E processing of third-party data in relation to persons and specifically the targeting of unsolicited information;
(b) the re-use of data that has been illegally 'extracted';
(c) the enrichment of data collected for one purpose with data that connects it to physical or virtual identities of people and / or their physical location;
(d) the difference between advertisement and search results needs to be clearly stated;
(e) the definition and implementation oversight of a standardised widespread privacy policy – including the data retention period as defined by Art.29 WG;
(f) the definition and implementation of standardized procedures related to labels and/or audits for the diligent handling and protection of sensitive data that could be self-enforced (e.g. an adapted and modernized version of the OECD[305] recommendations to privacy of 1980 in an effort to create a comprehensive data protection system throughout Europe);
(g) the launching of initiatives aiming at raising public awareness so as to apply pressure on internet service providers to protect user data more diligently and not to store it longer than absolutely necessary;
(h) the creation and administration of centres to help future victims of data loss or theft;
(i) the elaboration of legal studies to research under what conditions automated servers and algorithms may be held liable;
(j) the further study of the likely impact of regulation on innovation in the S-E area so as to help create a non-oligopolistic market by encouraging plurality of S-E technologies;
(k) the study of the use of self-regulation to intervene in the likely conflict between S-E operators and other service providers

[305] Organization for Economic Cooperation and Development (OECD): “Recommendations of the Council Concerning Guidelines Governing the Protection of Privacy and Trans-Border Flows of Personal Data”

In addition, technological solutions exist, are being and need to continue being developed to mitigate many of the above identified challenges in parallel to any legislative measures undertaken. The European Commission has recently announced the public support for Privacy Enhancing Technologies (PET) to address online and offline privacy threats. Among those technologies mostly discussed by experts are: (i) proxy servers to buffer between users' computers and the web; (ii) “Tor” (or “Onion Router”) encrypting the users' internet traffic and sending it through a series of randomly selected computers, thus covering the traces of a search query; (iii) the browser extension technology called TrackMeNot[306] which periodically issues randomized search queries to leading search engines, thereby concealing the users' actual search traces in a cluster of unintended queries; and (iv) Scroogle[307] which is a web service that disguises the internet address of users who want to run Google and Yahoo searches anonymously. The later is a service is run by Public Information Research, Inc., a non-profit corporation that also operates Google Watch. Besides anonymous searches, the tool allows users to perform Google searches without receiving Google advertisements.

In any case more privacy enhancing technological solutions are needed and specific research on this issue may prove worth while. However, it is well known that technological solutions require IT-skilled users, tenacity and creativity to by-pass the many obstacles intentionally raised in addition to awareness of the privacy infringement. As was mentioned also previously, these have got to be complemented by legal certainty.

[306] http://mrl.nyu.edu/~dhowe/TrackMeNot/
[307] http://scroogle.org/

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Abstract

This report is one of the outcomes of the EPIS06 Project – European Perspectives on the Information Society – carried out by the ETEPS (European Techno-Economic Policy Support) network in cooperation with the Joint Research Centre Institute for Prospective Technological Studies (JRC IPTS) with the aim of providing strategic intelligence to policy makers by taking a prospective view on the evolution of ICT.

This report combines the Annual Monitoring Synthesis (AMS) Report and five Emerging Trend Updates (ETU). It forms one of the main building blocks of the project, establishing an observatory of trends in technology and business evolutions of ICT.

More particularly, the Annual Monitoring Synthesis Report (AMS Report) aims to identify new ICT-related developments likely to have a significant impact on the future of the Information Society, both in terms of growth and jobs for Europe and R&D policy prioritisation. By scanning and monitoring recent major foresight exercises and industrial technology roadmaps, as well as other future-oriented analysis and policy papers, the AMS attempts to detect early signals and possible disruptive forces so as to enable timely policy responses and anticipate potential challenges for policy makers. The AMS is structured along six main themes which emerged as a result of the analysis:

- Convergence of infrastructures,
- Human-computer convergence – technologies for direct human computer interaction,
- Pervasive or ubiquitous computing and ambient intelligence,
- The future of the Internet,
- Citizens' concerns,
- Working life.

A structured overview with a summary of each of the foresights, roadmaps and other sources studied is presented in the AMS report annex.

In addition, five Emerging Trends Updates (ETU) present the results of focused briefs on emerging themes of interest for policy making, covering the following topics:
- ETU1 on the state-of-the-art of the creative content sector,
- ETU2 on ICT and the offshoring of services,
- ETU3 on ICT and the role of ICTs as enablers for energy efficiency,
- ETU4 on ICT tools and services in intelligent domestic and personal environments,
- ETU5 on ICT and privacy in the Knowledge Society – the case of search engines.