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A Strategy for ICT R&D and Innovation in Europe: Raising the Game

{COM(2009) 116 final}

CONTENTS

INTRODUCTION

This Staff Working Document accompanies the Commission Communication 'A strategy for ICT R&D and innovation in Europe'.

The Communication proposes a strategy for ICT research, development and innovation (R&D&I) in the EU with a view to establishing Europe's industrial and technological leadership in ICT, making Europe more attractive to investments in ICT R&D&I and to the best ICT skills, and ensuring that Europe's economy and society benefit fully from ICT developments.

The Communication forms part of the preparations for a European plan for innovation and research, encompassing the main technologies of the future including ICT, as called for by the European Council[1]. It is also part of the Commission's response[2] to the recommendations of the 2008 Aho Panel's evaluation of ICT R&D in the EU Research Framework Programme[3]. The proposed approach cuts across several policy areas including information society policy, research and innovation policy, as well as specific sector policies such as for health and energy. It builds on several existing initiatives and actions, notably the i2010 ICT policy framework and its central pillar on 'Innovation and Investment in Research', the broad-based EU innovation strategy and the five new initiatives launched in 2008 in the field of the ERA (i.e. on researchers, research infrastructures, knowledge sharing and intellectual property management, joint programming, and international science and technology cooperation), and substantiates these for the ICT area.

ICT is at the heart of the EU policies for knowledge and innovation, growth and jobs, and sustainable development. ICT provides the essential infrastructures and tools for knowledge creation, sharing and diffusion, it underpins economic growth, and it plays an important role in addressing key societal challenges from ageing and inclusion to lower carbon emissions and higher energy efficiency.

The economic and societal role of ICT is highlighted in all major recent EU and international reports on innovation, competitiveness, growth and sustainable development. This includes the 2006 Aho report[4], the ECFIN yearly economic reports[5] and the latest national reports. The recent Attali report[6] in France mentions the digital revolution as the revolution not to be missed and calls for higher investment in this sector and in mastering the relevant technologies. The newly launched IKT 2020 initiative[7] in Germany highlights also the importance of ICT to the whole economy and aims to reinforce Germany's technology and industrial presence in the sector.

Given its instrumental role in boosting the innovation capacity and improving the efficiency of all businesses, ICT contributes today to more than 40% of our overall productivity growth[8]. The ICT world market has reached €2 000 billion, and is currently growing at around 4% per year. Europe's ICT market represents 34% of this[9], and the size of the ICT sector in Europe represents 4.5% of EU aggregate GDP and even more if the value added of ICT in other sectors is also accounted for.

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[1] European Council Conclusions, 12.12.2008.
[2] COM(2008) 533: Commission's initial reactions and measures already taken or planned in response to the 2008 Aho Panel report: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0533:FIN:EN:PDF.
[3] Aho Panel: 'Ex-post Evaluation of European ICT R&D 2002-06 (IST R&D under FP6)', 2008: http://ec.europa.eu/dgs/information_society/evaluation/data/pdf/fp6_ict_expost/ist-fp6_panel_report.pdf.
[4] Aho Group: 'Creating an Innovative Europe', 2006: http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm.
[5] The EU Economy. Yearly Review: http://ec.europa.eu/economy_finance/publications/publ_page8701_en.htm.
[6] Rapport de la Commission pour la libération de la croissance française (Attali report), 2008: http://lesrapports.ladocumentationfrancaise.fr/BRP/084000041/0000.pdf.
[7] IKT 2020 initiative, Germany: http://www.bmbf.de/de/9069.php.
[8] Van Ark: 'EU KLEMS Growth and Productivity Accounts', 2007: http://www.euklems.net/data/overview_07II.pdf.
[9] IDATE, 'DigiWorld Yearbook 2007'.

The importance of ICT to economic and social change is reflected in R&D and innovation budgets worldwide, where ICT typically represents more than 30% of the total research effort[10]. This also shows that we are still only in the early stages of the ICT revolution: new breakthroughs in digital technology will continue in the next decades to bring new and ever more wide-ranging applications of ICT. The ICT sector is very R&D-intensive, with companies spending 10-20% of their turnover on R&D — because they know that an in-house research capability is essential to be able to assimilate technology and exploit it to economic advantage.

The ICT sector is also the main driving force of R&D in Europe. In the EU, ICT research accounts for a third of all research employment, more than a quarter of all private R&D spending, and more than a fifth of all patents, a share which has risen considerably over the last fifteen years[11]. In addition, ICT research also takes place in other industries, such as in so-called embedded computing systems. Even so, investment in ICT R&D remains the Achilles heel of the EU in competition with other advanced economies, accounting for almost half of the gap in research spending with both the US and Japan.

[10] OECD report, 2003, 'ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms'.
[11] PREDICT study report by EC/JRC/IPTS: http://ftp.jrc.es/EURdoc/JRC45723_RR.pdf.

CONSULTATIONS AND EXPERTISE

This section runs through the main messages from a wide range of information sources: stakeholder consultations, pertinent studies and reports, and the most relevant policy communications. Table 1 below gives an overview of major sources and Annex I contains a more detailed summary of each of them.

Raising investments in ICT R&D and innovation in Europe

The ICT business sector is the largest R&D investing sector in Europe, ahead of the automotive and pharmaceutical industries, accounting for 27% of the business R&D investments of all economic sectors combined. In 2005, the ICT business sector in the EU spent €35 billion on R&D. Even so, the EU's ICT business sector spends about 40% less on R&D than the US, not only in absolute amounts, but also as share of GDP[12]. Of all economic sectors, the ICT sector alone is responsible for as much of the economy-wide R&D investment gap between the EU and the US as all other sectors combined.

European public funding of ICT R&D is also significantly lower than elsewhere, and there are significant disparities between the Member States[13].

In July 2008, at an informal Competitiveness Council meeting[14], ministers called for more public investment at national and European level in ICT research to overcome the current deficit. They pointed to the need to secure new public and private sources of funding e.g. through more extensive utilisation of public procurement of ICT R&D services, as advocated in particular by the Commission in its Communication on Pre-commercial Procurement[15].

Prioritising and reducing the fragmentation of ICT R&D efforts

Compared to today's support for ICT R&D, the research ministers called for increased efforts to master and shape the future developments in important ICT areas such as the Future Internet, as well as greater efforts in ICT-based research infrastructures.

These are also the topics looked into in more detail recently by the National ICT Research Directors Forum[16], a twice-yearly meeting of representatives of national ministries responsible for ICT research policy and funding. The Forum has identified the need, not only for increased support, but also for increased networking and coordination of European excellence in these fields. And the FP7[17] ICT advisory group, ISTAG, have confirmed the Future Internet as an important area in which to build leadership.

Essential for success in joint programming of research and in pooling resources is the development of simple governance and management structures with a minimum administrative burden. This was another conclusion from the July 2008 informal Competitiveness Council. It confirmed the findings of the 2008 Aho Panel's evaluation[18] of ICT research under FP6. The 2008 Aho Panel concluded that European ICT research investment has been well managed and has been effective in reaching

[12] PREDICT study report by EC/JRC/IPTS: http://ftp.jrc.es/EURdoc/JRC45723_RR.pdf.
[13] Report from the Groupement Français de l'Industrie de l'Information (GFII) to the Ministère de l'Éducation nationale, de l'enseignement supérieur et de la recherche (2007), http://www.recherche.gouv.fr/cid20858/analyse-statistique-des-investissements-en-r-d.html.
[14] 'Informal Competitiveness Meeting, July 2008': http://www.ue2008.fr/PFUE/lang/en/accueil/PFUE-07_2008/PFUE-17.07.2008/resultats_de_la_reunion_informelle_competitivite__journee_recherche.
[15] COM(2007) 799: 'Pre-commercial Procurement', http://ec.europa.eu/invest-in-research/pdf/download_en/com_2007_799.pdf.
[16] 'National ICT Research Directors Forum': http://ec.europa.eu/information_society/research/coordination/ict_forum/index_en.htm.
[17] Seventh Framework Programme of the European Community for research, technological development and demonstration activities.
[18] Aho Panel: 'Ex-post Evaluation of European ICT R&D 2002-06 (IST R&D under FP6)', 2008: http://ec.europa.eu/dgs/information_society/evaluation/data/pdf/fp6_ict_expost/ist-fp6_panel_report.pdf.

its goals. However, the Panel also said that improvements can be made in simplifying and making the funding mechanisms more flexible by developing a more trust-based approach towards participants at all stages.

Facilitating the emergence of innovation-friendly markets for ICT-based products and services

Another important conclusion of the 2008 Aho Panel concerns the need to improve the underlying environment for ICT-based innovations in the EU. The panel stressed the need for a 'systemic' approach to ICT R&D&I that favours both the supply of and the demand for ICT R&D, addressing both the knowledge triangle in ICT (research, innovation and skills) and the demand side.

The call for a focus on the creation of innovation-friendly markets in Europe came from the 2006 Aho Group [19], which advocated large-scale strategic actions in key sectors to provide an environment in which supply-side measures for research investment can be combined with the process of creating demand and a market.

The proposal was elaborated in parallel by ISTAG, which confirmed the importance of developing lead markets for innovative ICT solutions addressing Europe's key societal challenges[20].

The 2008 Aho Panel recommended a number of actions to be undertaken, such as promoting stronger interactions between users, researchers and business, especially in regional ICT innovation systems, supporting new initiatives that would allow public authorities to procure the development of innovative ICT goods and services, and setting up mechanisms to help new and high-growth companies to meet venture capital investors.

Also on these points, ISTAG supports the Aho Panel by recommending the creation of early forums and dialogues with all stakeholders — on technology, business and regulatory matters — and including industry, academia, national and European authorities.

A final recommendation in common between the research ministers, the Aho Panel and ISTAG concerns the use of the European Institute of Technology (EIT) to establish Knowledge and Innovation Communities (KICs) in ICT. This, they say, would bring the relevant industry, research institutes and universities closer together, help build excellence in Europe and attract researchers and investments to Europe.

[19] Aho Group: 'Creating an Innovative Europe', 2006: http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm.
[20] ISTAG: 'Shaping Europe's future through ICT': ftp://ftp.cordis.europa.eu/pub/ist/docs/istag-shaping-europe-future-ict-march-2006-en.pdf.

Main information sources
Stakeholder consultations ICT R&D and innovation policy • Competitiveness Council's informal meeting in Versailles, July 2008 • National IST Directors Forum • ICT Advisory Group (ISTAG) • Ex-Post Evaluation of the FP6 IST Thematic priority (2008 Aho Panel) • Public on-line consultation: ICT R&D and Innovation • ICT European Technology Platform Leaders ICT addressing socio-economic challenges • i2010 high level group and subgroups • eSafety Forum • High Level group on ICT for energy efficiency
Studies and reports Economic analyses • PREDICT and GFII • EU-KLEMS ICT R&D impact analysis • Impact Analysis of FP/IST domains Innovation strategy • Europe Innova synthesis report European Research Area (ERA) • ERA Rationales Report International programmes • ICT strategies of major international competitors
Policy communications ICT policy • i2010 mid-term review ICT addressing socio-economic challenges • ICT for energy efficiency • i2010 e-Health Action Plan: Making healthcare better for European citizens • i2010 e-Government Action Plan: Accelerating eGovernment in Europe for the benefit of all • i2010 initiative on e-Inclusion: To be part of the information society • Towards Europe-wide safer, cleaner and efficient mobility: The first intelligent car report • E-skills for the 21st Century: fostering Competitiveness, Growth and Jobs; The use of ICT for innovation and lifelong learning for all; Digital literacy report; Recommendation on key competences; Updated strategic framework for European co-operation in education and training; New skills for New Jobs Innovation policy • Putting knowledge into practice: a broad-based innovation strategy for the EU • A lead market initiative for Europe & the eHealth task force report • European Institute of Innovation and Technology (EIT) • Pre-commercial Procurement • Towards world-class clusters in the European Union • Removing obstacles to cross-border investments by venture capital funds • Think Small First: A Small Business Act for Europe European Research Area (ERA) policy • Better careers and more mobility: A European partnership for researchers • Towards joint programming in research • Commission Recommendation on the Council Regulation on the Community legal framework for a European Research Infrastructure • Management of Intellectual Property Rights in knowledge transfer activities • A strategic European framework for international science and technology cooperation Regional policy • Regions delivering innovation through cohesion policy • Competitive European Regions through Research and Innovation

Table 1: Main information sources:
stakeholder consultations, studies & reports, policy communications

PROBLEM DEFINITION

1.1 What are the main problems?

1.1.1 Underinvestment in ICT R&D and innovation in Europe

While Europe represents the largest share (34%) of the world's ICT market, the value added of its ICT sector amounts to only 23% of the total[21]. Although ICT represents one of the largest export sectors of the EU (10% of all exports), it also accounts for a large proportion of our imports (around 14.5% of imports). The deficit is in key strategic technologies such as computing systems, software and components.

In relation to its population, Europe generates fewer patents with high economic value than the US or Japan[22]. In 2003 the EU-27 filed 34 so-called Triadic patents per million population versus 68 for the US and 106 for Japan[23]. The US also has a higher share of patent applications at the European Patent Office (27%) than the EU has at the US Patent Office (16%). In ICT, Europe also lags behind: the shares are 25% for the EU versus 37% for the US[24].

In addition, there is a growing deficit in the EU in the flow of highly qualified skills in ICT R&D. Experts estimate that the gap in ICT skills represents several hundreds of thousands of unfilled posts. Europe has only relatively very few world-recognised ICT poles of excellence, and this is affecting the attractiveness of ICT to pupils, students and researchers as well as to private investments in ICT innovation.

The ICT business sector stands as one of the largest R&D investing sectors in Europe, contributing to more than a quarter of all business R&D investments by all economic sectors combined. Even so, the EU ICT business sector spends only about half as much on R&D as its US counterpart. This is true both in absolute amounts and relative to the size of the economy. The ICT sector alone is responsible for as much of the economy-wide R&D investment gap between the EU and the US as all other sectors combined. This ICT business sector R&D gap reflects two facts: the ICT business sector is a smaller part of the economy in the EU than in the US, and the R&D intensity (business R&D/value added) of the ICT sector is lower in the EU[25].

European public funding of ICT R&D is also significantly lower than elsewhere, and there are significant disparities between the Member States[26]. EU R&D intensity has stagnated since the mid-1990s. In 2005, less than 1.9% of GDP was spent on R&D in the EU-27, a level still significantly lower than in the US (2.67%), Japan (3.17%) or South Korea (2.99%). Sweden and Finland are already well above the 3% targets, while Germany, Denmark, Austria and France are the only other Member States with R&D intensities above the EU average. If Member States achieve the R&D intensity targets announced in their National Reform Programmes, average R&D expenditure in the EU will increase to 2.5% in 2010[27].

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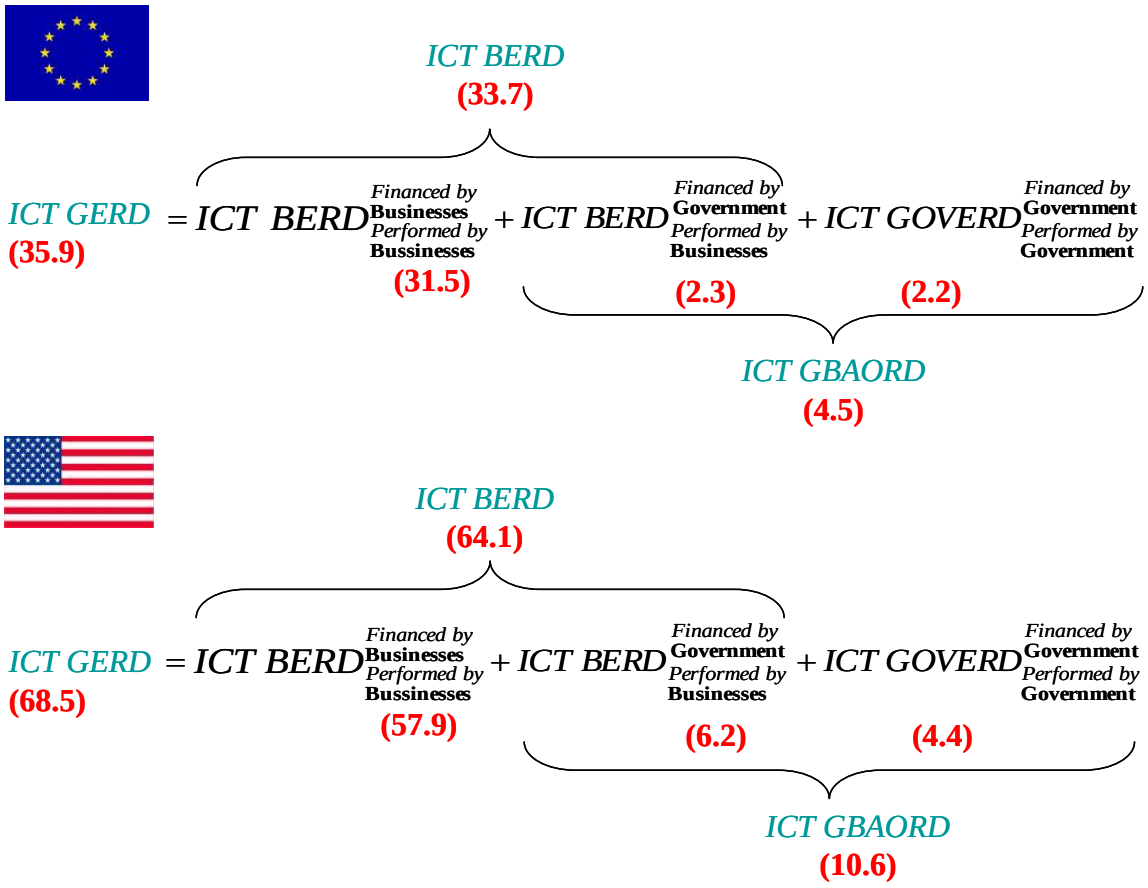
[21] 'European Information Technology Observatory yearbook 2007', www.eito.com.
[22] Note that the US, Japanese and EU patent system are different.
[23] 'Key figures 2007 on Science, Technology and Innovation: Towards a European Knowledge Area', http://ec.europa.eu/invest-in-research/pdf/download_en/keyfigures_071030_web.pdf.
[24] SEC(2005) 430/3, Commission Staff Working Paper, Annex to the Proposal for the 7th Framework Programme, Main Report: Overall summary, Impact Assessment and Ex-ante evaluation, http://cordis.europa.eu/documents/documentlibrary/72661491EN6.pdf.
[25] PREDICT study report by EC/JRC/IPTS: http://ftp.jrc.es/EURdoc/JRC45723_RR.pdf.
[26] Report from the Groupement Français de l'Industrie de l'Information (GFII) to the Ministère de l'Éducation nationale, de l'enseignement supérieur et de la recherche (2007), http://www.recherche.gouv.fr/cid20858/analyse-statistique-des-investissements-en-r-d.html.
[27] SEC(2008) 470: 'Commission Staff Working Paper, Annex to i2010 Mid-Term Review', http://ec.europa.eu/information_society/eeurope/i2010/docs/annual_report/2008/sec_2008_470_Vol_1.pdf.

In absolute numbers, the ICT business sector in the EU spent € 33.7 bn on R&D in 2005 (BERD). This was far below the USA at € 64.1 bn (in PPP exchange rates), but more than Japan (€ 26.8 bn), Korea (€ 10.9 bn) and Australia (€ 1.5 bn). These € 33.7 bn invested in ICT research amount to 0.31% of EU GDP (this is the contribution of the ICT sector to total BERD intensity (BERD/GDP)), whilst the € 64.1 bn spent in the USA correspond to 0.61% of the US GDP, a contribution twice the EU level. The contribution of the ICT sector to total BERD intensity was however much higher in Japan, and even more in Korea, where it is four times the EU level. Among the countries used in this comparison, only Australia has a lower level than the EU.

Both in the USA and in EU27 the share of total ICT GERD performed by business sector (ICT BERD) is as high as 94%:



Investments in new businesses in ICT by venture capital firms and business angels are more than 6 times less in the EU than the US. California alone attracts twice as much venture capital as the whole of Europe. Silicon Valley and San Diego are still the investment hotbeds as they represent one third of all VC investments worldwide — 10 out of 30 billion euros in 2007[28]. Measures such as the European Investment Fund (under the CIP) and the Risk-Sharing Finance Facility (under FP7 for Research) help improve the situation, but more can certainly be done to extend the scope of available finance (venture capital, loans) and facilitate access to it.

[28] 'Global venture capital insights and trends report 2008': http://www.ey.com/Global/assets.nsf/International/SGM_Global_VC_Insight_2008/$file/SGM_Global_VC_Insight_Report_2008.pdf.

Although businesses in the EU devote 20%[29] of investment to ICT, this is still relatively low, in particular in market services, compared to business uptake of ICT in other parts of the world.

1.1.2 Fragmented ICT R&D and innovation efforts in Europe

Despite recent pioneering efforts, not least through the launch of Joint Technology Initiatives under FP7 (Artemis and Eniac) and Joint Research Programmes (AAL) based on Treaty Art. 169, Europe's ICT research landscape remains fragmented. There is a lack of collaboration and coordination between R&D programmes — public and private, national and European. This is particularly true for the ICT field where, relative to the situation for other S&T fields, a low-to-medium degree of coordination/fragmentation is observed[30].

While some coordination actions have allowed some progress, only few examples exist of concrete initiatives between Member States or in common agenda setting in areas of strategic importance. This is also one of the factors preventing Europe from developing centres of excellence that are highly attractive to private investments.

Little if any interlinkage can be seen between policies related to the knowledge triangle. It is often the case that research and innovation policies are drawn up by different ministries or at different levels (e.g. one is national and the other is regional) without proper coordination. An important and telling example is cluster policy. In several Member States, strategies for innovation clusters are often drawn up in isolation from the policies for research facilities and scientific and education poles. For ICT, innovation clusters built around knowledge hubs (world-class research and education facilities) are essential to reach the research and industrial excellence that will draw private investments and the best skills. These clusters have a decisive role in pulling skills, national as well as worldwide skills, into ICT and ICT research and innovation careers in Europe.

The consequences of this fragmentation — on the supply side, on the demand side, and across supply and demand — are: unnecessary duplication of efforts, complications in pooling of resources, difficulties in addressing common challenges jointly and, in the end, sub-optimal returns on R&D investments.

1.1.3 Missing opportunities to lead in ICT transformations, to spur ICT business growth and to exploit the full potential of ICT

With these underlying trends, the risk is that Europe misses the opportunities to lead in new ICT transformations, to spur new ICT business growth, and to exploit the full potential of ICT to respond to Europe's socio-economic challenges:

- Missing opportunities to lead in new ICT transformations

  Today, we see a number of important transformations emerging in ICT. Those that lead these changes will also be those that will attract investments and skills.

  Europe should, for example, be in a leading position to develop, master and shape the Future Internet that will gradually replace our current network and service infrastructures. We should also be at the forefront of developing the next-generation ICT components and their applications, and leading in addressing the sustainability challenge with ICT.

- Missing opportunities to spur new ICT business growth

  High-growth ICT companies contribute to wealth through the creation of new business and jobs. They provide high returns for investors, promote regional development, generate satisfaction for

[29] COM(2008) 199: 'The i2010 Mid-term review': http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0199:FIN:EN:PDF.
[30] COM(2008) 468: 'Towards joint programming in research': http://ec.europa.eu/research/press/2008/pdf/com_2008_468_en.pdf.

managers and employees, and make a significant contribution to job creation. Several empirical studies confirm the importance of high-growth firms for job creation. In the UK, for example, 4% of new start-up survivors were responsible for 50% of jobs created by all new firms 10 years later[31].

With regard to business dynamics, entry and exit rates as well as survival rates, the latest European Competitiveness Report[32] concludes that these 'are largely comparable across the EU countries and the US. The main differences being that (i) in the US successful new firms expand more rapidly than in the EU; (ii) entrants in the US display a higher dispersion of productivity levels than in Europe; and (iii) in the US the more productive firms have a stronger tendency to increase their market shares than in the EU. Taken together these findings suggest that the market environment is more competitive in the US, but at the same time allows greater market experimentation. In addition, the evidence indicates that, relative to the US, barriers to growth pose a bigger problem than barriers to start a business in the EU'.

- Missing opportunities to exploit the full potential of ICT

  The role of ICT becomes ever more important as Europe has to adjust to the changing economic realities brought about by the globalisation of markets, production and research and the ever-faster pace of technological change.

  ICT also helps us address many of the major societal challenges that our citizens are facing: it brings substantial improvements and completely new ways of addressing challenges in areas such as health, learning, security, energy and the environment. It also facilitates the inclusion of regions and communities in an enlarged Europe.

  Finally, ICT is a key factor for innovation in all major scientific fields, from biotechnologies to materials science.

1.2 What are the underlying causes?

1.2.1 Lack of awareness of the importance of ICT R&D&I in a globalised economy

Although ICT products and services from the internet to PCs and mobile and fixed communications are today in common use, the effort needed to innovate and compete in this field is often underestimated in Europe as well as the breadth of opportunities that such an effort engenders.

What is often underestimated also is the importance of ICT research, development and innovation not only for the competitiveness of the ICT sector but also and above all for the competitiveness of the whole economy and for the ability to address the key societal challenges ahead. To be able to compete today on a global scale in any field, an economy has to be able to embrace innovations and make the best use of them at the earliest stage. With ICT underlying innovations in all businesses, it is only through the development of a solid knowledge base in ICT and by shaping its development that Europe will be able to make the best of the technology throughout its economy.

The role that ICT R&D&I plays in addressing societal challenges is often undervalued also. For example, the importance of ICT research and development to bring innovative radical solutions to monitor our health and support the research, diagnosis, management and even cure of critical or chronic diseases is often unknown to policymakers. The same applies to energy efficiency or to climate change.

1.2.2 No single market for innovative ICT-based products and services in Europe

[31] COM(2007) 860: 'A Lead Market Initiative for Europe': http://ec.europa.eu/enterprise/leadmarket/doc/com_07_en.pdf.
[32] 'European Competitiveness Report 2008': http://ec.europa.eu/enterprise/enterprise_policy/competitiveness/1_eucompetrep/eu_compet_reports.htm.

The continued fragmentation of the European marketplace for ICT-based innovative products and services is one of the main factors behind the lower level of investments in ICT R&D&I in Europe, and efforts must continue to address the framework conditions for a more coherent, integrated single market in this field.

Although liberalisation of the telecom sector is overall a European success story — that has delivered more choice, higher quality and cheaper prices for all of us — a real internal market in telecoms is still some way from being a reality. The same is true for other ICT and ICT-based products and services.

The framework conditions for regulation, standardisation and intellectual property regimes are insufficient when the goal is to facilitate the emergence of competitive, open and innovation-friendly markets and to support the early commercialisation of research results.

Current standardisation structures and processes in Europe are not sufficiently reactive and fast, and there is no clear separation between missions that require public intervention and those more related to market dynamics[33]. European IPR policies can be more effective, and without the adoption of the Community patent the single market in IPR is incomplete[34].

Clearly, a wide range of policy measures and actions, going well beyond those to be outlined in the Framework Communication on 'ICT R&D and innovation', are needed to fully address this underlying cause.

1.2.3 Insufficient uptake of innovative ICT in public sector services

The fragmentation of public demand and the relatively slower uptake of ICT-based innovations in the public sector in Europe are major weaknesses that are affecting the quality and efficiency of our public services.

There is often little coordination and collaboration between public authorities in charge of procuring innovative ICT-based solutions in different ministries (e.g. for health, transport, energy) and R&D/innovation ministries. This means insufficient awareness of new public service needs versus technological innovations and weak links between programmes for R&D, innovation, and procurement.

Pre-commercial procurement of ICT to modernise services in areas of public interest is today heavily underutilised in Europe. It represents less than €1bn in the EU against more than €10bn in the US[35].

This is also identified by industry as one of the important deficiencies to be addressed in order to strengthen Europe's innovation capacity, to shorten the time-to-market of innovations and to improve Europe's attractiveness to investment in ICT research and innovation.

1.2.4 Complicated ICT R&D and innovation funding mechanisms

The EU, the Member States and intergovernmental bodies have complementary policies and actions in place to support research and innovation in Europe. Although plenty of information is available on the different funding sources, potential beneficiaries are often still confused, in particular when it comes to deciding which source of funding is most appropriate for a given activity[36]. To provide guidance on the use of Community Funds, the Commission has published the 'Practical Guide to EU funding opportunities for Research and Innovation'. Note also that, whilst the Commission can

[33] http://ec.europa.eu/enterprise/standards_policy/index_en.htm.
[34] http://ec.europa.eu/internal_market/indprop/index_en.htm.
[35] COM(2007) 799: 'Pre-commercial Procurement': http://ec.europa.eu/invest-in-research/pdf/download_en/com_2007_799.pdf.
[36] 'Practical Guide to EU funding opportunities for Research and Innovation': http://cordis.europa.eu/eu-funding-guide/home_en.html.

ensure synergies in terms of designing policies and funding instruments, Member States and regional authorities play the main role in ensuring co-ordinated implementation[37].

Regarding EU funding of ICT research, the Aho Panel's evaluation of the Information Society Technologies programme under FP6[38] concluded that the ICT programme was implemented and managed efficiently and, according to several stakeholders, was one of the better managed thematic priorities in FP6. However, the Panel also recommended further simplification and increased flexibility.

Concerns relate mainly to the following key issues: heavy administrative burdens, high application costs, high oversubscription rates, and long times to contract. The main recommendation is to develop a more trust-based approach towards participants at all stages. "At the application stage, it is recommended that shorter proposals are required with fewer details of work packages and a focus on the appropriateness of partnerships, in particular the inclusion of highly innovative participants. At the proposals evaluation stage, it is recommended that more complete and helpful feedback is made available to proposers whose ideas are not funded. At the stage of project management, the Panel recommends optimising reporting and allowing more flexibility in refocusing the research and in the composition of partnerships".

Simpler and more flexible mechanisms introduced with the launch of FP7 (flat-rate funding for overheads, guarantee fund, unique participant registration, etc.) are important parts of the simplification effort and are to be complemented by further steps to be taken by the Commission in the next years to ameliorate the procedures and the financial and administrative requirements for actors who wish to benefit from EU research funding.

Clearly, a wide range of policy measures and actions, going well beyond those to be outlined in the Framework Communication on 'ICT R&D and innovation', are needed to fully address this underlying cause.

[37] COM: Competitive European Regions through Research and Innovation – a contribution to more growth and more and better jobs
[38] Aho Panel: 'Ex-post Evaluation of European ICT R&D 2002-06 (IST R&D under FP6)', 2008: http://ec.europa.eu/dgs/information_society/evaluation/data/pdf/fp6_ict_expost/ist-fp6_panel_report.pdf.

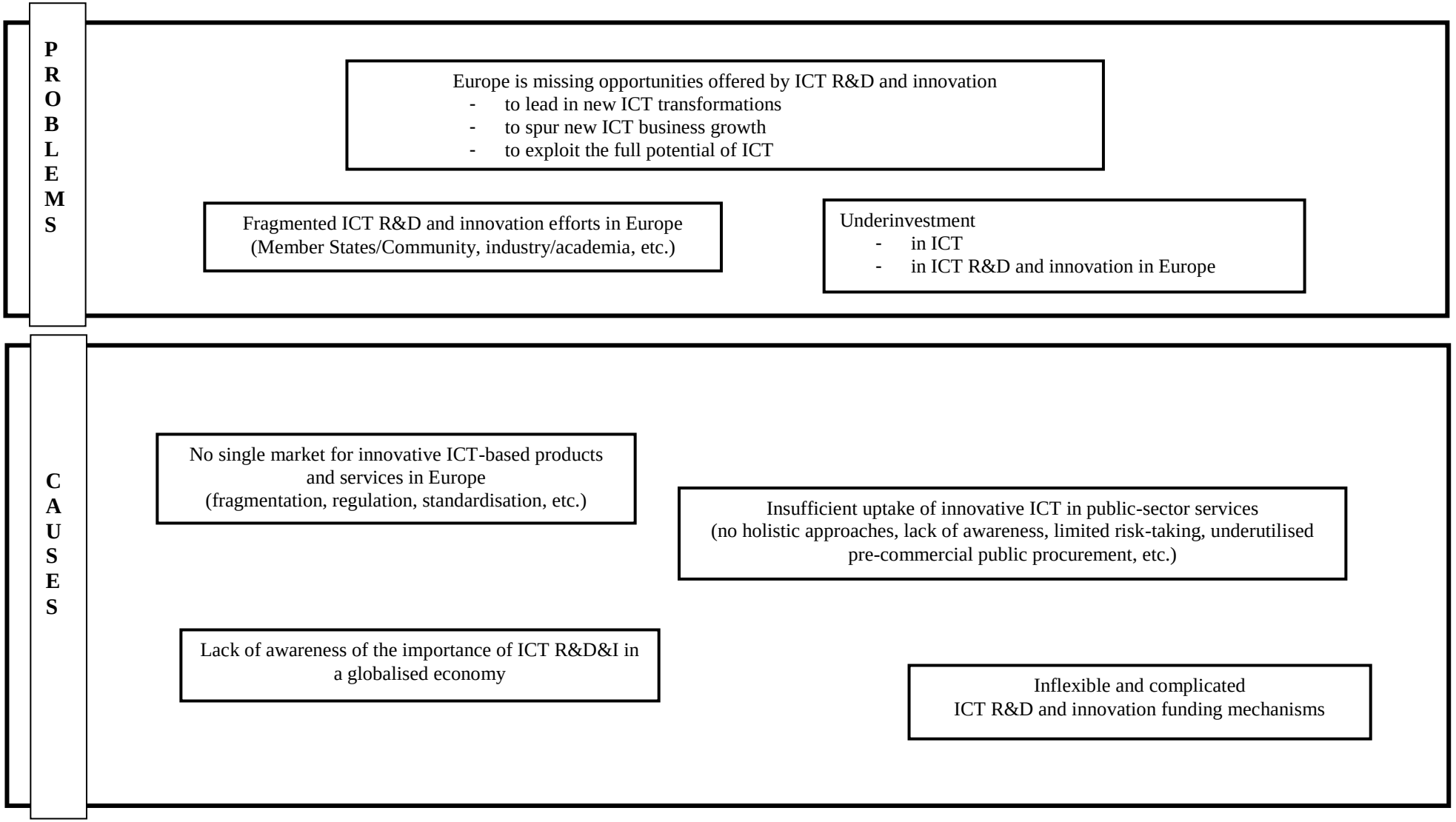


Figure 1: Problems and causes related to the situation of ICT R&D and innovation in Europe.
The causes do not match the problems in a one-to-one relationship; it is the various combinations of them which lead to the observable problems.

1.3 How do the causes affect different stakeholders?

The stakeholders affected by the causes are the ICT R&D and innovation suppliers, users and policymakers. These can be grouped into the traditional sections of industry, academia, public sector and society.

<table>
<tr><th></th><th>Industry</th><th>Academia</th><th>Public sector</th><th>Society</th></tr>
<tr><td>No single market for innovative ICT-based products and services in Europe</td><td>- less competitive, less innovative
- limited economies of scale
- underexploiting the ICT potential, less productive</td><td rowspan="2">- less industry/academia collaboration
- fewer spin-offs from academia</td><td rowspan="3">- unable to meet the needs stemming from societal challenges such as ageing populations, rising energy costs, congested transport systems
- underexploiting the ICT potential, less productive
- higher costs, restricted choice</td><td>- less choice
- higher prices
- lower quality</td></tr>
<tr><td>Insufficient uptake of innovative ICT in public sector services</td><td>- reduced market size
- longer time-to-market
- lower innovation capacity
- less attractive to investments</td><td>- less quality and efficiency of public services</td></tr>
<tr><td>Lack of awareness of the importance of ICT R&D&I in a globalised economy</td><td colspan="2">- missed opportunities to lead in new ICT transformations
- lack of competitiveness
- low recognition of strengths of European ICT R&D and innovation
- lack of world-class ICT poles of excellence
- less effective in knowledge creation, sharing and diffusion</td><td rowspan="2">- lower ability to propose solutions to societal challenges
- less efficient and effective returns on investments
- failure to attract highest quality research and innovation activities</td><td rowspan="2">- less choice
- higher prices
- lower quality
- higher dependency on 'foreign' technologies
- lower competitiveness of the whole economy</td></tr>
<tr><td>Inflexible and complicated ICT R&D and innovation funding mechanisms</td><td colspan="2">- less efficient and effective returns on investments</td></tr>
</table>

Table 2: Effects of causes on stakeholders

1.4 Legal basis for EU action

EC Treaty Articles 157 and 163-173 can be used as the legal basis for proposing policy measures and actions that would strengthen the competitiveness of industry in Europe through support for R&D and innovation activities.

1.5 Confirmation of added value of EU action

In the face of globalising markets, shortening innovation cycles and more interdependencies in ICT and ICT-based solutions, it is increasingly beyond the reach of any single organisation or country to master critical parts of the value chains.

Partnering at European level is essential to provide the strategic direction, to integrate the necessary critical mass of know-how, capabilities, skills and financial resources to pursue common goals, and to ensure that ICT and ICT-based solutions are applicable across Europe and beyond.

Joint planning and coordination can optimise the use of available resources, avoid overlaps and duplications and allow national authorities to share the risk of implementing innovative solutions. Experience and knowledge can be shared to raise awareness of opportunities offered by ICT, how to

create a holistic approach in public policies and how to encourage uptake of ICT in businesses and in the public sector.

The critical mass needed can often only be reached through collaborations at EU level, e.g. for defragmenting the markets, gathering the resources needed for investment in infrastructure and creating the framework for an attractive large European R&D area for researchers and students.

The development of an internal market for ICT innovation depends on common agreements at EU level on standards and interoperability. The framework conditions for growth and development of SMEs can no longer be tackled at national level alone in the current context of globalisation and international markets.

A balanced strategy is needed, respecting the principles of subsidiarity, proportionality and additionality. Planning of actions needs to be shared by stakeholders — private and public, at Community, national, regional and local levels — and can be implemented in variable configurations at different levels.

In most cases the role of the Community is to facilitate multilateral transnational collaborations between actors. Actions with Community financial support must remain focused on initiatives of significant scale and duration, and they must continue to build on, leverage and add value to national, regional and private initiatives and funds.

1.6 General policy objectives

The objective of the Communication is to propose a policy approach that will enable Europe to lead, master and shape ICT developments in the next decade, facilitate the emergence of new markets and the growth of new business and make Europe more attractive to investments in ICT R&D&I and the best ICT skills.

To reinforce our strengths and seize new opportunities, we need to raise our game. We must continue to mobilise the stakeholders around ambitious goals and roadmaps for European leadership in ICT. Europe can, and should, be in a leading position to shape and benefit from future developments in this sector.

1.7 Specific policy objectives

To support the general policy objectives, Europe must increase the intensity and impact of its ICT R&D and innovation investments: we must invest more and better and stimulate wider uptake and better use of ICT across the economy and society.

The specific policy objectives are:

1. **Raising investments in ICT R&D and innovation through reorientation and new sources of financing**

   We must strengthen the financing of ICT R&D and innovation across Europe. This involves reorienting some existing public resources as well as finding new public and private sources of funding.

2. **Prioritising ICT R&D and innovation in Europe into key areas and reducing the fragmentation of the effort**

   Europe must increase its capacities to exploit synergies and build excellence. We must become more systemic in concentrating and specialising our resources in research and knowledge hubs, clusters, platforms and partnerships to attract the best researchers and private investments in ICT to Europe.

3. **Facilitating the emergence of new public and private markets for ICT-based innovative solutions**

   To ensure competitive, open, innovation-friendly markets, foster business development, facilitate the growth of new business in ICT, and support the earlier commercialisation of research results, we need to step up our efforts to adapt factors such as regulation, standardisation, intellectual property regimes and public procurement.

   The ICT innovation eco-system, from R&D to uptake and deployment, must become more efficient in a combined 'demand pull'/'supply push' approach. This should lead to more innovation and leadership in public and private markets.

At the same time, collaboration and competition will de facto extend beyond the EU's frontiers to jointly respond to major global technological and societal challenges and address scientific and technological cooperation of mutual benefit while ensuring Europe's competitiveness and avoiding free distribution of European knowledge. It is therefore important to strengthen the coordination of Member State and EU-level actions to reinforce strategic cooperation with partners worldwide and enhance the global position of European industry.

The investments must be well managed and we must continue to make improvements in the governance and operation of the instruments that we have at our disposal. Serious efforts must be made to further cut red tape and streamline complex research administration when we pool our efforts. Also needed are regular re-assessments of effectiveness and efficiency of direct management versus indirect management by delegation to more independent structures.

To be able to measure the achievement of these objectives, the following indicators are proposed:

Being the world's largest economy and representing the largest share of the world's ICT market, Europe can have legitimate ambitions for its businesses, governments, research centres and universities:

- By 2020, Europe should double private investment in ICT research and development and double investment in high-growth SMEs through e.g. venture capital and business angels in ICT[39].
- By 2020, public investment in ICT R&D should be strengthened to reach double its current level (around €6bn[40]) mainly through pre-commercial public procurement of ICT research and innovations, which should reach at least €6bn in 2020, or around three times its current level[41].
- By 2020, Europe should nurture at least an additional five ICT world-class poles of excellence, measured by private and public investments in the pole.
- Europe should grow new innovative businesses in ICT so that, by 2020, one third of all business expenditure in ICT R&D is invested by companies created after 2000[42].
- By 2020, the EU ICT sector should supply the equivalent of its share of the global ICT market[43].

[39] See section 2, in particular: the current level of private investment in ICT R&D in Europe is around €35bn, or 60% less than the US level (ref. PREDICT study report by EC/JRC/IPTS: http://ftp.jrc.es/EURdoc/JRC45723_RR.pdf). Today, the investments of venture capital and business angels are around €5bn in the EU, against more than €30bn in the US (ref. European Venture Capital Association Yearly Report, http://www.evca.eu/default.aspx).

[40] Report from the Groupement Français de l'Industrie de l'Information (GFII) to the Ministère de l'Éducation nationale, de l'enseignement supérieur et de la recherche (2007), http://www.recherche.gouv.fr/cid20858/analyse-statistique-des-investissements-en-r-d.html.

[41] COM(2007) 799: 'Pre-commercial Procurement': http://ec.europa.eu/invest-in-research/pdf/download_en/com_2007_799.pdf.

[42] See section 2, in particular: businesses (SMEs mainly) created after 1985 represent today around 15% of total R&D expenditure according to data compilation from the sector; only 5% of European companies which are now in the world top 1 000 in terms of market capitalisation were created after 1980 (ref. study on 'Innovative ICT SMEs in Europe', carried out by IDC for DG INFSO, 2008).

[43] See section 2, in particular: in 2005, Europe represented more than 32% of the global ICT market, and Europe supplied around 22% of the global ICT market (ref. European Competitiveness Report 2006: http://ec.europa.eu/enterprise/enterprise_policy/competitiveness/1_eucompetrep/eu_compet_reports.htm).

POLICY OPTIONS

Although the problems and causes have been formulated simply and specific policy objectives have been established, the number of possible policy options exceeds what can be analysed in a staff working document of this kind (i.e. for a strategy that has no immediate and direct budgetary or regulatory consequences) because the systems involved are complex and multi-faceted. Furthermore, follow-up communications will be subject to dedicated consultations and detailed impact assessments for each action.

Basically, policy options can be designed along four main dimensions: (1) the degree of EU/Member States interactions and collaborations, (2) the degree of supply-led and/or demand-led innovation measures, (3) the intensity of investments, and (4) the degree of public-private interactions and collaborations.

It is considered that, under all circumstances, private-public partnerships are essential. ICT is the research and innovation area where the private sector is the most active. Private investment represents more than 80% of the total effort. Therefore any research and innovation policy for ICT has to involve the private sector from the outset. ICT is also an area where the public sector effort is playing a key role in supporting groundbreaking work that has led to major achievements so far such as the internet in the US, or the web and GSM in Europe. It is an area where EU public programmes and collaboration frameworks such as Eureka have been particularly successful.

It is also implicit that the intensity of investments in ICT R&D and innovation must increase. As mentioned above, the ICT sector alone is responsible for as much of the economy-wide R&D investment gap between the EU and the US as all other sectors combined.

This leaves a design of policy options along the dimensions of (1) EU/Member States partnerships and (2) supply/demand-led innovation.

Figure 2 illustrates the four policy options considered.

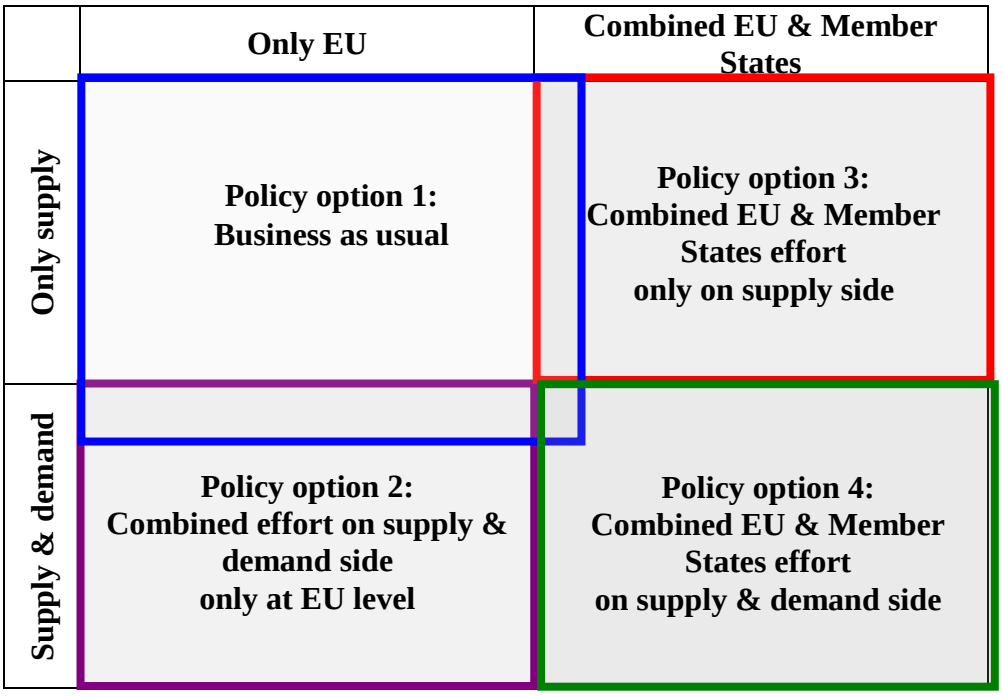


Figure 2: Policy options

Figure 3 below presents the current landscape of ICT R&D and innovation initiatives mapped along these dimensions.

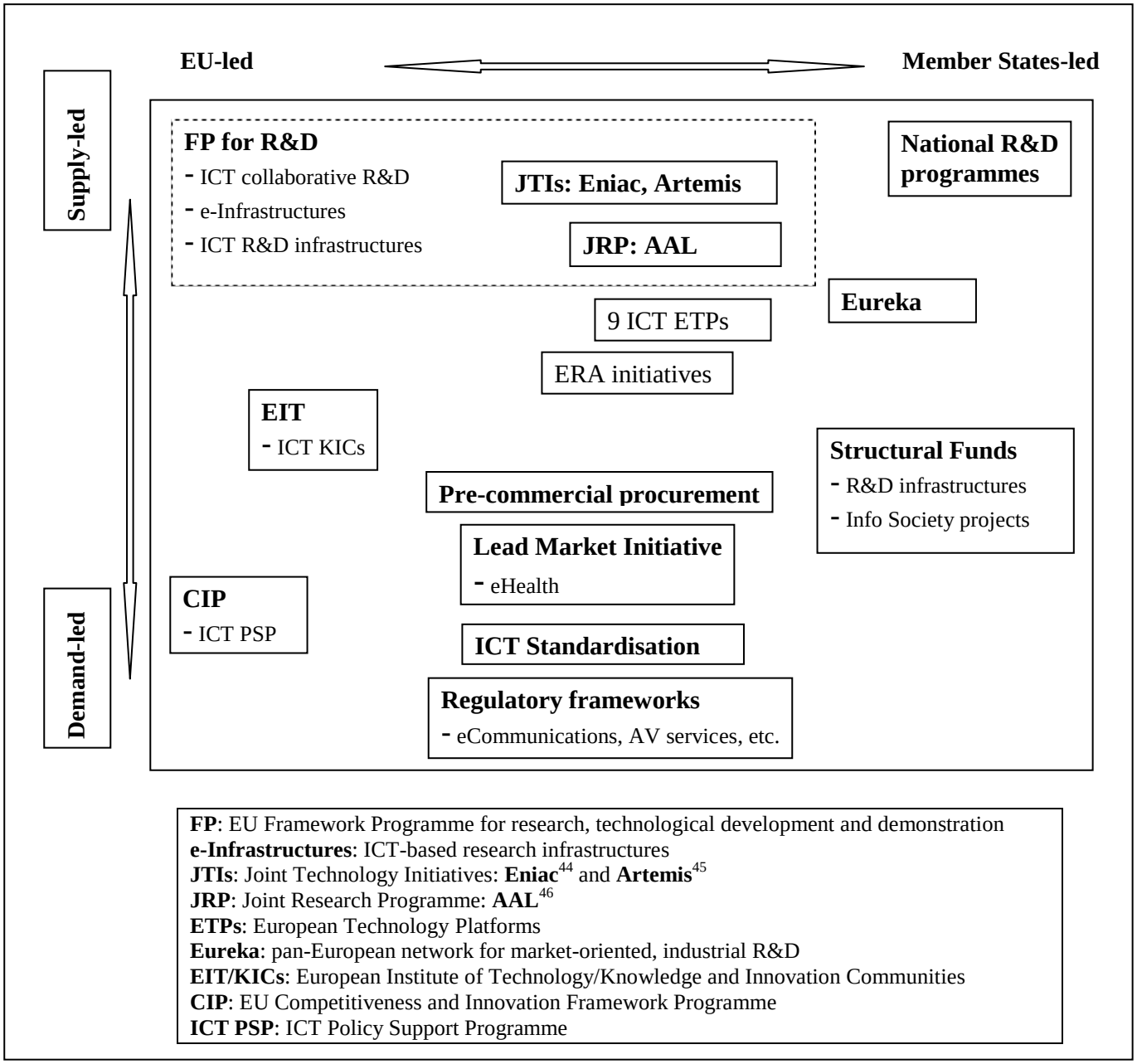


Figure 3: Current ICT R&D and innovation initiatives

1.8 Policy option 1: 'Business as usual'

This option, as illustrated in Figure 3 above, places the main weight on Community-level actions (Framework Programmes for research (FP) and for innovation (CIP)), mostly on the supply side (FP).

The relative allocations to EU-level ICT collaborative research projects would remain constant. Only a very limited number of initiatives would involve additional national and industry funds,

[44] Eniac: European Nanoelectronics Initiative Advisory Council: http://www.eniac.eu/.
[45] Artemis: Embedded Computing Systems Initiative: http://www.artemis.eu/.
[46] AAL: The Ambient Assisted Living Joint Programme: http://www.aal-europe.eu/.

such as the two current Joint Technology Initiatives (JTI), Eniac and Artemis, and one Joint National Programme (JNP), AAL.

Shared research infrastructures would continue to focus on high-capacity electronic communication networks and grid infrastructures (e-Infrastructures) such as the current GÉANT and EGEE[47]. There would be only very limited action in support of common research facilities for undertaking ICT research such as nanoelectronics clean-rooms or software service development testbeds.

National research programmes and the Eureka programme would continue in a fragmented way.

Knowledge and Innovation Community/ies (KICs) under the EIT would be launched mainly based on Community funds. Links between education, research and innovation would mainly be related to European-level activities.

Support for demand-led innovation would take place mainly through limited funds allocated in the CIP programme and sparse resources allocated by Member States through the Structural Funds, together with a few 'softer' measures such as promoting approaches for the emergence of lead markets, or encouraging more strategic use of pre-commercial public procurement.

1.9 Policy option 2: 'Combined effort on supply & demand side only at EU level'

Compared to the 'business as usual' option, this option would strengthen EU-led actions for demand-led innovation.

Anticipated under this option is financial support for one or two European-scale projects that each cut across the innovation chain — from support for R&D projects and infrastructures and stimulation of ICT uptake, through piloting of existing innovative solutions to evaluate feasibility and cost-efficiency, to facilitation of procurement of R&D and innovation, testing and validation against performance targets and deployment under operational conditions. (Examples of such European-scale projects are provided in Annex II.)

Orchestrated efforts would offer different measures — R&D, pilots, feasibility studies and deployment — under one umbrella project. This is in contrast with the current set of available measures where project promoters have to combine many different sources of funding, at different levels, for different project phases.

The option also involves a substantial increase in support for ICT uptake in the ICT Policy Support Programme under the CIP, to pilot and showcase more innovative ICT-based solutions, in particular in public sector services.

Finally, under this option, ICT KICs would not have any substantial additional impact, compared to policy option 1, on reinforcing Europe's capacity to transform education and research results into societal and business innovations.

Under the option the Community would be in charge of carrying out strategic assessments of the need for a European-level critical mass of publicly supported ICT research and innovation to help solve major socio-economic challenges facing the EU. The Community would also take the lead in selecting the most appropriate EU instruments needed to implement the selected actions.

1.10 Policy option 3: 'Combined EU and Member States effort only on supply side'

Compared to the 'business as usual' option, this option calls for stronger coordination and collaboration between the Community and the Member States on supply-side measures.

[47] GÉANT and EGEE: Pan-European high-capacity and high-performance communication network (GÉANT) and Enabling Grids for E-sciencE (EGEE): http://cordis.europa.eu/fp7/ict/e-infrastructure/home_en.html.

This involves more support for EU-level ICT collaborative research projects, including more Joint Technology Initiatives and more Joint National Programmes in the ICT field.

In addition, this option envisages the establishment of a number of multilateral transnational R&D programmes without any additional contribution from the EU.

Support for shared research infrastructures would also be increased, not only through funds from the Framework Programme for research, but also through the Structural Funds and national funds for building R&D facilities.

Priority topics, instruments and procedures for providing reinforced support to supply-side measures would be determined by a systemic process of concentration and specialisation of resources. Rationalisation of closely related programmes and measures, as well as streamlining of management and administrative procedures, would be important results. This would build on the experience of the pioneering actions (Joint Technology Initiatives, Joint National Programmes, etc.) in key ICT areas where substantial public and private research and innovation efforts are pooled at Community and national level.

Under this policy option, measures for demand-led innovation would remain 'soft', in the form of awareness and promotion, exchange of best practices, and recommendations.

1.11 Policy option 4: 'Combined EU and Member States effort on supply & demand side'

This option involves a larger set of stakeholders (policymakers, industry, academia) from across the Community, Member States, regional and local levels, and includes the strengthening of programmes on both the supply and the demand side, as well as support for new European-scale projects that cut across the innovation chain.

As under policy option 3 ('Combined EU and Member States effort only on supply side') this involves increased support for ICT collaborative research projects under the EU Framework Programme for research and in multilateral transnational R&D programmes, as well as more support for shared European ICT research infrastructures, all within a framework of more systemic concentration and specialisation of resources in research and knowledge hubs and partnerships. This requires targeted actions at all levels of ICT innovation, research, education and training.

In contrast with policy option 3, however, this option would also include European-scale projects (examples are provided in Annex II) that cut across the innovation chain, as well as increased ICT policy support under the CIP, stronger support for Information Society projects under cohesion policy programmes, and strong support from Member States and the Community for ICT Knowledge and Innovation Communities under the EIT.

Also unlike policy option 3, the coordination actions under this option would not only work on the supply side. They would extend to the demand side through cross-portfolio collaboration between users of ICT innovations (in health ministries, transport ministries, etc.) and R&D/innovation ministries, to deliver shared roadmaps of public service needs placed on an axis reflecting technological maturity of possible solutions. Again, this would result in higher rationalisation of measures and streamlining of procedures.

As under policy option 2 ('Combined effort on supply & demand side only at EU level') this coordination process would identify priority topics and instruments for a set of projects ranging from support for R&D and stimulation of ICT uptake to facilitation of procurement of R&D and innovation, testing, validation and deployment under operational conditions.

However, under policy option 4 there would be much broader and stronger coordination and collaboration with similar actions at Member State, regional and local levels. The Member States, and not the Community, would take the lead in identifying topics for common action and selecting

the most appropriate instruments for implementation. The Commission would play the role of facilitator. The wider cooperation with national and regional stakeholders would aim to reduce the risks and costs inherent in acquiring innovative solutions and to pool demand, which in turn should provide suppliers with better market prospects.

Such collaboration frameworks would be established on a case-by-case basis for specific innovative ICT-based solutions to specific societal problems. As under policy option 2, orchestrated efforts would offer different measures under one umbrella project.

Under this option, new sources of funding would involve more strategic use of pre-commercial public procurement of ICT R&D services, as well as enhanced schemes for access to venture capital and loans for ICT R&D.

ANALYSIS OF IMPACTS

In assessing the impacts of pursuing each of the options, they have been grouped into two main types, for reasons of simplicity:

- Main economic impacts:
  - Impact on innovation capacity and productivity of industry and of public sector
  - Impact on scale and growth of business and markets
  - Impact on efficiency of research and innovation systems.

  These impacts are described in Table 3 below.
- Main societal and environmental impacts:
  - Impact on choice, price and quality for citizens and consumers
  - Impact on influence of concerns for society
  - Impact on the environment.

  These are described in Table 4 below.

1.12 Economic impacts

The table below describes the main economic impacts of the specific policy options:

Policy option 1: 'Business as usual'	**Policy option 2: 'Combined effort on supply & demand side only at EU level'**	**Policy option 3: 'Combined EU and Member States effort only on supply side'**	**Policy option 4: 'Combined EU and Member States effort on supply & demand side'**
Current EU support for ICT research and innovation has been effective in many critical fields in supporting the competitiveness of European industry, in raising the capacities of the European knowledge base, and in building lasting partnerships.	For those cases of significant scale and duration where all Member States can agree on common projects supporting all phases — from R&D to uptake and deployment — positive impact can be expected in terms of new pan-European markets	Pioneering actions (Joint Technology Initiatives, Joint National Programmes, ETPs, CIP pilots) in key areas are pooling substantial public and private research efforts at Community and national level. In addition, some national programmes are starting to include openings for cross-border collaborations.	Promoting an efficient ICT innovation eco-system across Europe that combines demand- and supply-side measures and that includes more vertical user-producer interactions at all levels would facilitate the emergence of new markets with clearer demands from users allowing for faster responses to socio-economic challenges

The fragmentation of private and public markets for ICT products and services results in a less innovative, less productive and less competitive European industry. It also means less favourable conditions for the European economy to spur new ICT business growth, and for all sectors to exploit the full potential of ICT. The European ICT industry has more constraints than its competitors elsewhere when exploiting economies of scale. Too little uptake of innovative ICT in public sectors reduces the market size for the ICT industry in Europe and/or prolongs the time-to-market for new products and services. Fragmented research and innovation efforts mean missed opportunities for Europe's researchers, in industry and academia, to lead in new ICT transformations. The result is that Europe remains less attractive to investments in ICT R&D and innovation.	and shorter innovation cycles for the corresponding products and services. Single-umbrella supply/demand projects would increase cost-efficiency. A boost in support for ICT uptake, in particular in public sector services, will modernise services of public interest and expand market opportunities for suppliers of innovative ICT-based solutions. However, collaboration and coordination with similar initiatives at national or regional scale would remain weak, resulting in duplication of efforts, lack of exploitation of synergies and sub-critical mass.	This means: integrated efforts and more focused R&D agendas, more certainty in budgets and leveraged funding, and less duplication of evaluation and monitoring procedures. Stronger and more systemic concentration and specialisation of resources would rationalise measures, streamline procedures and reduce admin burdens. Industry and academia will benefit from increased coordination of the supply side, which will send clear messages on common priority topics targeted by the Member States and nurture more R&D excellence centres. New knowledge will be generated and turned into innovative products and services, but their time-to-market will not be significantly reduced. Hence, R&D investments will not be better exploited and incentives for business to invest in further R&D and innovation will not be created. Working only on half of the innovation cycle, there is a higher risk that the R&D results are exploited elsewhere, or not at all. This option will have limited impact on fragmented markets or on reducing the innovation gap. This means that Europe will miss considerable growth and job opportunities.	and opening up new opportunities for industry, in particular SMEs. The approach would lead to more rapid returns on investments and thus greater incentives for expanding private investment in ICT R&D projects and infrastructures and in production facilities. Single-umbrella supply/demand projects would increase cost-efficiency. Stronger and more systemic concentration and specialisation of resources would rationalise measures, streamline procedures and reduce admin burdens. The R&D and innovation landscape in Europe would become more attractive to investors, companies, researchers and students. The link between technology supply and applications would be stronger, notably through the strategic use of innovative and pre-commercial procurement. This would allow for more problem-focused ICT R&D development with easier uptake of new solutions and therefore shorter innovation cycles. Given the economic analyses of the effects of ICT investments, this should also result in higher productivity and increased exports, ultimately leading to higher growth levels.

Table 3: Economic impacts

1.13 Societal and environmental impacts

The table below describes the main societal and environmental impacts of the specific policy options.

Policy option 1: 'Business as usual'	**Policy option 2: 'Combined effort on supply & demand side but only at EU level'**	**Policy option 3: 'Combined EU and Member States effort but only on supply side'**	**Policy option 4: 'Combined EU and Member States effort on supply & demand side'**
The fact that there is still no single market for the digital economy in Europe means inadequate results in terms of choice, price and quality for EU consumers. The same is true for public services because of their insufficient uptake of innovative ICT. Emerging innovation initiatives on societal challenges (ICT for healthcare, energy efficiency, the environment, etc.) remain fragmented and do not move ahead at the required speed.	Decisions on projects of European scale risk being taken without adequate attention being paid to local concerns of a social nature. Only societal projects for which common agreement across all Member States can be found would be launched, whereas many problems, e.g. environmental issues, show large geographic disparities.	Users will not benefit fully from the advantages of new ICT. Societal and environmental demands will not be easily integrated into the R&D priority-setting processes, and therefore the utility of new solutions risks becoming suboptimal.	Larger parts of the public sector, not just those responsible for ICT R&D and innovation, would play an active role in setting the agenda. This raises awareness of technological opportunities and stimulates innovation in services of public interest. The impact on society would be greater in this option as the voice of public service needs would have greater influence, incorporating also social preoccupations such as trust, privacy and protection of personal data, ethics. Wider application of ICT innovations would accelerate advances in areas such as healthcare, energy efficiency and environmental monitoring and control. Positive impact in terms of welfare as a result of more innovation being made available sooner at reasonable pricing and responding better to users' needs. Positive impact in terms of employment as a result of economic growth.

Table 4: Societal and environmental impacts

COMPARING THE OPTIONS AGAINST THE POLICY OBJECTIVES

The most fundamental criteria to be applied when comparing the options are the degree to which each option would meet the specific policy objectives. These are used to identify and subsequently measure the strengths and weaknesses of each policy option:

- Raising investments in ICT R&D and innovation through reorientation and new sources of financing:
    - Capacity to strengthen, reorient and find new funding/investment sources
- Prioritising ICT R&D and innovation in Europe into key areas and reducing the fragmentation of the effort:
    - Capability to focus on topics of common priority
    - Ability to bring down redundancies and exploit synergies
    - Capacity to build closer links and critical mass
- Facilitating the emergence of new public and private markets for ICT-based innovative solutions:
    - Ability to accelerate the development of new markets
    - Capacity to speed up innovation cycles.

The grading of each criterion, on a scale [-], [0], [+], [++], is based on a comparison with 'Business as usual' which by definition is set to [0]:

- [-] is assigned when the option is likely to result in a deterioration of the current situation regarding the criterion
- [0] is assigned when no decisive impact is expected on the criterion from the option
- [+] is assigned when the option is likely to provide considerable impact on the criterion
- [++] is assigned when the option is likely to provide very significant impact on the criterion.

1.14 Impacts on the specific policy objectives

Table 5 below describes the impacts of each policy option on the specific policy objectives.

Policy option 1: 'Business as usual'	Policy option 2: 'Combined effort on supply & demand side only at EU level'	Policy option 3: 'Combined EU and Member States effort only on supply side'	Policy option 4: 'Combined EU and Member States effort on supply & demand side'
Raising investments in ICT R&D and innovation through reorientation and new sources of financing			
Many success stories have been effective in supporting the competitiveness of industry in Europe, in raising the research capacity of the European knowledge base, and in building new sustained partnerships. However, it is recognised that overall the current innovation pace is not enabling Europe to address its pressing socio-economic challenges and to lead in new ICT developments.	Initiatives addressing common European challenges and cutting across supply- and demand-side measures could help focus efforts and investments. However, subsidiarity concerns may limit the number and scope of such initiatives, as research and innovation is a shared competency between the EU and the Member States.	EU and national R&D funding programmes (collaborative research projects, research facilities, etc.) would be strengthened. The ability to form the optimal critical mass is facilitated through focused, flexible and visible prioritisation of topics for R&D. However, investment foci risk being biased towards 'technology push', driven only by overcoming technology roadblocks and reinforcing the strengths of the supply industry. No attraction of new funding sources, e.g. through pre-commercial procurement.	More coherent and integrated demand- and supply-led innovation policies are also likely to lead to reoriented spending priorities towards higher levels of direct financing to R&D. Demand-led innovation measures such as the promotion of pre-commercial public procurement represent new ways of, and new sources for, supporting R&D. For both industry and public authorities it would be easier to position initiatives vis-à-vis the full innovation cycle and in line with similar initiatives in other countries and at European level. This should increase risk taking.
Prioritising ICT R&D and innovation in Europe into key areas and reducing the fragmentation of the effort			
Today, some coordination is taking place in informal structures and bottom-up projects, such as in the Forum of National ICT Research Directors, JTIs, Joint National Programmes and ERA-NET-	Only a limited part of the total research and innovation effort in Europe would be addressed. Today, 85% of public R&D is programmed, financed, monitored and evaluated at national level. The bulk of	Collaboration and coordination across Europe would increase on the supply side. Building research and knowledge hubs, clusters and platforms would help raise Europe's	Supporting an ICT innovation eco-system across Europe that combines demand- and supply-side measures would allow R&D and innovation efforts to be focused on those socio-economic challenges that require common responses shared by stakeholders from several European countries. Becoming more systemic in pooling and coordinating

type actions. However, the intensity and nature of coordination and collaboration that has been achieved so far is relatively loose and does not significantly reduce fragmentation and exploit synergies. In particular, there is little cross-involvement of users, procurers, providers and policymakers.	demand-side actions are also under the responsibility of the Member States and their regions. Therefore, under this option, efforts would, at best, remain scattered amongst the Member States.	visibility and attractiveness. However, weak linkages between research and technological innovations, on the one hand, and public and private market needs, on the other hand, would limit the economic and societal impacts of pooling efforts on the supply side.	our resources and investments in ICT R&D and innovation across Europe — both on the demand and on the supply side — would lead to reduced fragmentation, less redundancies and better exploited synergies. Further concentration and specialisation in research and knowledge hubs, clusters and platforms in Europe would help ensure critical coverage, build excellence, and attract the best researchers and private investments in ICT to Europe. Cross-portfolio collaboration between users of ICT innovations and R&D/innovation ministries, supported by suppliers in industry and academia, would deliver shared roadmaps of public service needs placed on an axis reflecting technological maturity of possible solutions. This would lead to: (i) raised awareness and better coordinated public service needs versus technological innovations, (ii) wider use of opportunities in public procurement of innovation and of R&D, and (iii) closer linkages between programmes for R&D, innovation, and procurement. Better collaboration among policymakers, users and suppliers of ICT innovations would lead to more effective use of resources — from research to uptake and deployment, while re-orienting, increasing and more effectively utilising public and private investments. Sharing visions and jointly developing agendas and roadmaps would also allow Member States and their regions to better position themselves based on their individual strengths and weaknesses.
Facilitating the emergence of new public and private markets for ICT-based innovative solutions			

Loose frameworks, guidelines and promotion activities have been set in place to open new markets for innovative ICT products and services, e.g. the Lead Market Initiative and the Communication on Pre-commercial Procurement. However, the systemic nature of innovation is not taken into consideration. There are no single-umbrella European-scale projects covering the whole range from R&D and stimulation of technology uptake to procurement and deployment of solutions.	Only a limited part of relevant European markets would be addressed. Therefore, under this option, only a narrow set of measures could be taken at EU level to trigger a better link between demand and supply and accelerate the development of new markets.	New markets would not develop faster than today, conditions for the growth of SMEs would remain weak, and there would be a growing risk that investments in R&D in Europe are exploited elsewhere. Any promotion of new markets risks being biased towards 'technology push', driven only by the interests of technology suppliers.	The full picture of the innovation eco-system, from R&D to uptake and deployment, would be covered and measures at different stages of the cycle could be linked into a systemic strategy which would make each of them more effective. A combined 'demand pull'/'supply push' approach, not least for public sector services — including more strategic use of public procurement of ICT innovations — would enable public authorities to innovate faster and bring radical improvements to public services at local, regional, national and European level. This should lead to increased quality, effectiveness and efficiency of public services being delivered to Europe's citizens. At the same time, this approach would open up new markets of international industrial leadership for the European supplier base through the creation of competitive first-mover advantages. A concerted demand/supply approach would also support risk sharing and help develop economies of scale.

Table 5: Impacts of each policy option on the specific policy objectives

The scores according to the grading defined above are as follows:

Policy option 1: 'Business as usual'	Policy option 2: 'Combined effort on supply & demand side only at EU level'	Policy option 3: 'Combined EU and Member States effort only on supply side'	Policy option 4: 'Combined EU and Member States effort on supply & demand side'
Prioritising European ICT R&D into key areas and raising investment levels			
[0]	[+]	[+]	[++]
Reducing the fragmentation of ICT R&D and innovation effort in Europe			
[0]	[-]	[++]	[++]
Facilitating the emergence of new public and private markets			
[0]	[+]	[-]	[++]

Table 6: Scoring of degree to which each policy option meets the specific policy objectives

1.15 Preferred option

In the light of the above, policy option 4 'Combined EU and Member States effort on supply & demand side' is the preferred option.

Support for an efficient ICT innovation eco-system that combines demand- and supply-side measures and involves the EU, Member States and regional levels is clearly in line with the messages and recommendations coming from recent consultations and reports.

The choice of this option is expected to achieve the largest impact on public and private markets for the digital economy, on new ICT business developments and on increased investments in ICT R&D and innovation in Europe. As a result, the R&D and innovation landscape in Europe will become more attractive to investors, companies, researchers and students, and new markets will develop with a clear demand from users allowing for faster responses to socio-economic challenges and opening up new possibilities for industry, in particular innovative ICT SMEs.

1.15.1 Obstacles to compliance

Reorienting some of the public resources to raise the investment levels for ICT R&D and innovation will not be easy in the current economic downturn. It is therefore important to secure new public and private funding sources, e.g. through more strategic pre-commercial public procurement and reinforced schemes for access to finance.

Positive experience has already been gained in coordinating and pooling resources on the supply side (JTIs etc). However, there is little practice, at either European or national level, of collaboration between 'users' and 'suppliers' of ICT innovations in different ministries.

Compromises may have to be made to reach agreement on priorities e.g. for common challenges for ICT research and innovation projects, or for shared investments in new or extended infrastructures.

Financial support under a single budget line for European-scale projects of the type proposed above, ranging from support to R&D to piloting and final deployment, is not possible under the current EU

Financial Perspective. This would require an additional line of action in future Financial Perspectives.

MONITORING AND EVALUATION

1.16 Progress indicators

The following indicators will measure progress of the strategy:

- ICT market supply by European companies
- European private and public ICT R&D expenditure: total, by new companies, by poles of excellence
- Patents in the ICT sector
- Use of pre-commercial procurement in Europe
- Investment by venture capital and business angels in ICT in Europe

1.17 Broad outline for monitoring and evaluation arrangements

The monitoring and evaluation exercises to follow up on the above progress indicators can be based on available data collections such as those compiled by Eurostat[48], or the EVCA[49]. The work carried out by the JRC's IPTS under the PREDICT study which analyses private and public investments in ICT R&D will also support the monitoring.

- ICT market supply by European companies is reported in the European Competitiveness reports[50].
- European private and public ICT R&D expenditure and patents in the ICT sector will be followed through the PREDICT[51] study carried out by the JRC's IPTS.
- Use of pre-commercial procurement in Europe will be measured through the data on the Europe-wide tendered EU procurement market: all procurement by public agencies, utility companies, etc. through the EU Official Journal/Tenders Online Daily (European procurement database).
- Investments by venture capital and business angels in ICT in Europe are reported on in the EVCA yearly reports.

The figures will be monitored on a yearly basis and as a minimum reported in DG INFSO's Annual Activity Report. Other ways of reporting on these figures, for example through integration in the annual Key Figures Report, will be explored[52].

[48] http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1090,30070682,1090_33076576&_dad=portal&_schema=PORTAL.
[49] European Venture Capital Association: http://www.evca.eu/.
[50] http://ec.europa.eu/enterprise/enterprise_policy/competitiveness/1_eucompetrep/eu_compet_reports.htm.
[51] PREDICT study report by EC/JRC/IPTS: http://ftp.jrc.es/EURdoc/JRC45723_RR.pdf.
[52] 'Key figures 2007 on Science, Technology and Innovation: Towards a European Knowledge Area', http://ec.europa.eu/invest-in-research/pdf/download_en/keyfigures_071030_web.pdf.

ANNEX I: MAIN INFORMATION SOURCES

1.18 Stakeholder consultations

The various stakeholder groups comprise representation from industry (large and small), academia and national authorities. They have a well distributed geographic coverage and provide a good representation of the main ICT R&D and innovation 'constituencies' in Europe.

1.18.1 Competitiveness Council's informal meeting in Versailles , July 2008[53]

The research part of the informal Competitiveness Council on 17 July 2008 focused on the development of the European Research Area, particularly along the dimensions of (i) 'joint programming' of common research actions in the Member States and EU, (ii) higher mobility and better careers for European researchers, and (iii) a legal framework for shared European research infrastructures. One session covered the application of these dimensions in the ICT field.

The research ministers stressed the importance of ICT for the European economy and society and for science in all fields. They pointed out that Europe needs to do much better than today in terms of investments, industrial presence and innovation.

In particular, they called for:

- More public investment at national and European level in ICT research to overcome the current deficit. This should include securing new public and private sources of funding such as through more extensive utilisation of public procurement of ICT R&D services.
- A 'systemic' view that that joins research to innovation and commercialisation and to education, and that favours both the supply of and demand for ICT R&D. The use of the European Institute of Technology (EIT) to establish Knowledge and Innovation Communities (KICs) in ICT would help build excellence in Europe and attract researchers and investments.
- Stepping up efforts to master and shape the future development and use of the Future Internet, as well as strengthened efforts on ICT-based research infrastructures.
- Development of simple governance and management structures with minimum administrative burden. This is essential for success in 'joint programming' of research and in pooling resources.

1.18.2 Member States' National ICT Research Directors Forum[54]

The National ICT Research Directors Forum is a twice-yearly meeting (active since 2003) of the representatives of national ministries responsible for ICT research policy and funding. These representatives have been consulted on activities such as Joint Technology Initiatives (e.g. Artemis and Eniac), Joint National Programmes (e.g. AAL), the Communication on pre-commercial procurement, and the Lead Market Initiative. The Forum has also discussed topics such as 'ICT R&D and Globalisation' and 'ICT R&D skills'.

In two meetings in 2008 (May in Ljubljana, November in Lyon) the Directors were consulted on drafts of the Communication. Concerning the idea of European-scale projects addressing ICT-based solutions to societal challenges, the Forum recommended that ICT R&D and innovation for these should respond to the necessity and constraints of integrating with other policies. Priority topics should have a clear selection rationale, deliver concrete results and have high visibility. Global competitiveness should remain a major driver.

[53] 'Informal Competitiveness Meeting, July 2008': http://www.ue2008.fr/PFUE/lang/en/accueil/PFUE-07_2008/PFUE-17.07.2008/resultats_de_la_reunion_informelle_competitivite__journee_recherche.
[54] 'National ICT Research Directors Forum': http://ec.europa.eu/information_society/research/coordination/ict_forum/index_en.htm.

The Forum looked into two other subjects in more detail through Working Groups active from May until November: one on 'the Future Internet' and one on 'Research Infrastructures'. Their main findings were as follows:

- For the Future Internet, European excellence in the field needs to be networked. There is not necessarily a need for new instruments, but the use of existing ones should be optimised, e.g. a Knowledge and Innovation Community (KIC) under the EIT, a Joint Technology Initiative, testbed facilities under the Cooperation or Capacities programmes. Actions undertaken should position themselves in an international context with respect to both collaboration and competition.

  Applications should be accounted for very early in the research process and should not be dealt with in a separate process. Testbeds could help achieve increased user involvement in the process.

- For Research Infrastructures better consideration needs to be given from the outset to the different users' requirements. These differ between academic and industrial research. Establishment of research infrastructures should result in innovation eco-systems flourishing around them in order to ensure a higher return to the investors, be they public or private. In addition to the work of ESFRI, multilateral coordination between Member States, with or without Community funding, is also important.

  The Forum explored in more detail how GÉANT can also serve as a research facility to support industrial needs in the form of testbeds/experimental facilities for large-scale pre-production research and validation, involving also end-users. The Forum also looked into challenges for better exploiting high-performance computational resources. They recommended that action should go beyond technology development and focus also on the needs for simulation and visualisation in areas such as design and manufacturing, digital content generation, health and environmental management. Finally, regarding nanoelectronics R&D facilities, the Forum pointed to the importance of addressing industrial needs throughout and the necessity of continued involvement of the national public authorities in the discussions.

1.18.3 ICT Advisory Group (ISTAG)[55]

ISTAG is the FP7 ICT advisory group. It provides a framework for interactions, at the highest level, with industry and academia. It constitutes also a powerful scheme for the development of shared approaches to ICT R&D between main actors in the field.

Several reports were produced over the last year[56] which set out the views of stakeholders on different topics linked to the Communication. The main recommendations from these reports are summarised below.

- Europe must marshal ICT to address its economic and societal challenges. Only ICT can deliver productivity increases across all economic sectors; only ICT allows us to find radically new solutions to Europe's major societal problems; and only ICT enables citizens and businesses to unlock creativity and innovation. At the same time, the nature of ICT is changing: ICT does not just enable us to *do* new things; it *shapes* how we do them.

- To make it attractive for companies to invest in ICT research in Europe it is essential to stimulate the development of lead markets for innovative ICT solutions addressing Europe's key societal challenges.

[55] ISTAG: http://cordis.europa.eu/ist/istag.htm.

[56] Most recent ISTAG reports: 'Future Internet', 'Web based services', 'Digital content', 'ICT and sustainability', 'ICT in the EIT', 'International cooperation in ICT R&D and European research hubs': http://cordis.europa.eu/ist/istag-reports.htm.

- The Future Internet is an area where industry could have more ability to create an atmosphere conducive to leadership, but the current instruments are not conducive to an obvious way forward.
    - It is essential that the architecture developed for the Future Internet is capable of sharing the reward from providing the end service down the value chain to the contributors of those elements used.
    - Both medium- and long-term trajectories should be taken for the Future Internet, securing successful 'quick win' ventures, on the one hand, but increasing service provisioning sophistication, not least for business-to-business and coupling the internet of services and the internet of things, on the other.
    - We should not work on too narrow scenarios, and there needs to be a focus on programmable/run time-defined approaches to resolving resource conflicts.
- In parallel with the technology research, it is important to create early forums and dialogues with all the stakeholders, on technology, business and regulation (vendors, service/content providers — old and new, users, developers and regulators). National strategic cross-cutting applications should be identified, and ways of bringing key industries together to the table should be fostered.
- Innovation in ICT can be shaped by an ICT Knowledge and Innovation Community under the EIT, through coordination which would bring the relevant industry, research institutes and universities closer together. Knowledge developed in an ICT KIC would also contribute to other KICs such as those envisioned on sustainability and energy.
- Implementing a strategy for international cooperation in ICT R&D requires suitable initiatives and measures to be identified, such as (1) reciprocal participation in EU/InCo programmes, (2) establishment of common shared research infrastructures, and (3) establishment of a number of joint labs, performing ICT research on topics of mutual interest, employing local human capital in the InCo country, under a joint ownership and financing scheme.

1.18.4 Ex-post evaluation of the IST thematic priority of the 6th FP (Aho Panel)

A wide range of studies relating to programme evaluation are available[57]. This section reports on the most recent and extensive exercise: the 2008 Aho Panel's evaluation of IST under FP6.

The Aho Panel[58] concluded that European ICT research investment has been well managed and has been effective in reaching its goals. However, improvements can be made in terms of making the funding mechanisms simpler and more flexible, by developing a more trust-based approach towards participants at all stages, and by adopting a number of changes at the operational level, for example requesting shorter proposals, exploring new evaluation processes, optimising reporting.

The Aho Panel also stressed that exploitation of the knowledge and skills created depends on a broad portfolio of policies and measures which affect the innovation 'eco-system'. The Panel urged the Commission to take the opportunity of improving the environment for innovation from ICT research among other things by:

- Reintroducing mechanisms to help new and high-growth companies to meet venture capital investors;

[57] EC/DG INFSO studies and reports: http://ec.europa.eu/dgs/information_society/evaluation/studies/index_en.htm.
[58] Aho Panel: 'Ex-post Evaluation of European ICT R&D 2002-06 (IST R&D under FP6)', 2008: http://ec.europa.eu/dgs/information_society/evaluation/data/pdf/fp6_ict_expost/ist-fp6_panel_report.pdf.

- Promoting stronger interactions between users, researchers and business — e.g. in regional innovation systems;
- Supporting new initiatives to allow public authorities to procure the development of innovative ICT goods and services;
- Promoting interoperability and development of standards where there is a well-documented need for coherent innovative services and European leadership;
- Facilitating the development of lead markets for innovative ICT products and services;
- Strengthening collaboration and mobilising public-private partnerships, as in the Joint Technology Initiatives.

In the Commission's initial reactions[59] to the report from the Aho Panel, the Commission agrees that the European innovation environment is critical to the effective exploitation of ICT research results, and it welcomes in particular the Panel's recommendations on the need for systemic changes. It also commits to continue efforts to simplify and reduce administrative burdens, within the constraints of sound financial management.

1.18.5 'ICT R&D and Innovation' public on-line consultation

See separate report on: http://ec.europa.eu/information_society/tl/research/index_en.htm

1.18.6 ICT European Technology Platform Leaders[60]

At regular intervals meetings between all the ICT European Technology Platform[61] (ETP) leaders and the Commission are held to discuss policy issues of concern to the ETPs.

In February 2008 the meeting addressed the role of ETPs in the development and implementation of ICT R&D and innovation policies. The following main points were made:

- ETPs have improved the coordination of R&D activities in ICT by mobilising and organising industrial and academic research teams around unifying themes, developing shared visions, and drawing up roadmaps. The ETP's Strategic Research Agendas have been, and continue to be, useful tools for guiding research strategies of both public and private stakeholders, be it at regional, national or EU level.
- In addition to JTIs more lightweight mechanisms are needed and the added value of current arrangements as compared to trilateral and bilateral agreements is yet to be demonstrated.
- ETPs are ready to venture into the areas such as pre-commercial public procurement and lead markets, but would appreciate the presence of the EC as facilitator for a coordinated approach.
- International collaboration is an important aspect for which a strategy at EU level is needed, in order to avoid the selling out of European knowledge without any return.
- During the meeting four thematic orientations were discussed in more detail: the Future Internet, alternative paths for components and systems, ICT and environmental sustainability, and trust and confidence in the digital economy. In each of these areas there is a basic consensus for enhanced cooperation.

1.18.7 i2010 High Level Group and subgroups (eHealth, eInclusion, eGovernment)[62]

[59] COM(2008) 533: Commission's initial reactions and measures already taken or planned in response to the 2008 Aho Panel report: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0533:FIN:EN:PDF.
[60] ICT European Technology Platforms: http://cordis.europa.eu/ist/about/techn-platform.htm.
[61] The ICT ETPs are: eMobility, NESSI, NEM, ISI, ENIAC, ARTEMIS, EPoSS, Photonics21 and EUROP.

The Commission has set up a High Level Group of Member States' representatives, at Director General level, to advise on the implementation and development of the i2010 strategy. The Group reviews the effectiveness of i2010 and gives advice on possible improvements and adjustments, using benchmarking to monitor i2010 implementation and policy evolution. It also offers a forum for exchanging experience on issues relevant to i2010 which are covered by the Lisbon National Reform Programmes. The High Level Group is assisted by three subgroups:

- The eHealth subgroup brings together key decision-makers and leaders of national eHealth initiatives. They are joined by key stakeholders drawn from telecommunications ministries, health authorities, doctors' and nurses' associations, industry, as well as patient and citizen groups. The group contributes to the implementation of the eHealth action plan[63]. The subgroup has promoted eHealth to improve quality of, and access to, healthcare, while bolstering the cost-effectiveness of eHealth systems and services.
- The eInclusion subgroup contributes to the implementation of the Riga Ministerial Declaration[64] and supported the preparation of the 2008 European Initiative on eInclusion. The subgroup has promoted two areas: ICT for ageing well and eAccessibility. It has also encouraged engagement in policy activities on ICT for social capital.
- The eGovernment subgroup contributes to the implementation of the i2010 eGovernment Action Plan[65]. The participants represent ministries responsible for eGovernment policies or their implementation. The subgroup has promoted cooperation between governments to allow for economies of scale in Member States' initiatives. The subgroup has also taken action to ensure the involvement of all stakeholders in designing and delivering eGovernment.

1.18.8 High-level group on Energy efficiency

The spring 2008 Communication 'Addressing the Challenge of Energy Efficiency through ICT[66]' called for a consultation and partnership process on ICT for Energy Efficiency. During 2008 the main elements of this process were an on-line public consultation and the convening of an ad hoc advisory group consisting of ICT providers in industry and academia, and end-users including regional and city groups.

The on-line consultation for energy efficiency confirmed a focus for actions on ICT-enabled improvements in energy efficiency in areas such as heating and lighting buildings, manufacturing, transport and electrical power distribution, as well as ICT-enabled structural change to new services and practices.

The ad hoc advisory group concluded that ICT is a key enabler to support the achievement of the EU energy efficiency targets and the transition to a low carbon economy and society. ICT should continue to make a significant impact, not only by reducing its own carbon footprint but, more significantly, by enabling energy efficiencies in other sectors: construction, manufacturing, transport, etc.

1.18.9 eSafety Forum[67]

[62] i2010 High Level Group and subgroups: http://ec.europa.eu/information_society/eeurope/i2010/high_level_group/index_en.htm.
[63] COM(2004) 356: 'eHealth Action Plan': http://ec.europa.eu/information_society/doc/qualif/health/COM_2004_0356_F_EN_ACTE.pdf.
[64] Riga Ministerial Declaration: http://ec.europa.eu/information_society/events/ict_riga_2006/doc/declaration_riga.pdf.
[65] COM(2006) 173: 'eGoverment Action Plan': http://ec.europa.eu/information_society/activities/egovernment/docs/highlights/comm_pdf_com_2006_0173_f_en_acte.pdf.
[66] COM(2008) 241: 'Addressing the challenge of energy efficiency through ICT': http://ec.europa.eu/information_society/activities/sustainable_growth/docs/com_2008_241_1_en.pdf.
[67] eSafety Forum: http://www.esafetysupport.org.

The eSafety Forum is a joint platform involving road safety stakeholders from the public sector and industry (including the automotive industry, service providers, user clubs, the insurance industry). The Forum promotes advances in the development, deployment and use of ICT for improving road safety in Europe. The Forum has issued recommendations on issues such as: required data collections, regulatory issues, standardisation and certification.

1.19 Studies and reports

A large number of relevant studies and reports exists. This section highlights the results of the most important ones.

1.19.1 Economic Analyses: PREDICT[68] and GFII[69]

The PREDICT (2005-2011) study collect and analyse data on R&D spending in the ICT industry. So far, the focus of the study has been on macro-economic data regarding Businesses Expenditure on Research and Development (BERD), which accounts for over 80% of the total R&D in the ICT sector. To supplement the analysis with company data, the project also uses data from the EU Industrial R&D Investment Scoreboard[70], which tracks R&D spending by the biggest 1 000 European and non-European R&D spenders. PREDICT extends this with collection and analysis of data sets on Government Expenditure on R&D (GERD). A preliminary analysis of the ICT innovation systems in the Member States has also been undertaken.

The studies have shown that the ICT business sector is the largest R&D investing sector in Europe, ahead of the automotive and pharmaceutical industries, accounting for 27% of the business R&D investments of all economic sectors combined. In 2005, the ICT business sector in the EU spent €35 billion on R&D.

Even so, the EU's ICT business sector spends about 40% less on R&D than the US, not only in absolute amounts, but also as a share of GDP. Of all economic sectors, the ICT sector is by far the biggest contributor to the R&D gap between the EU and the US. On a more positive note, ICT sector BERD growth has recently picked up with the EU outperforming for the first time the US and getting much closer to Japan's growth rate.

The ICT business sector's R&D gap reflects two factors: first, the ICT business sector is a smaller part of the economy in the EU than in the US and, second, it shows a lower BERD intensity (business R&D/value added) in the EU as compared to the US. These observations vary widely when looking at company or country data: the R&D intensity of the individual ICT companies in Europe is fully comparable to the investment of companies that are active in the US. Europe's weakness is to be found in its difficulty to make innovative SMEs in the ICT sector grow and become world leaders.

Among EU Member States, Finland and Sweden host the highest R&D effort in the ICT sector, relative to their size. In general, northern Member States show higher ICT R&D intensity than southern Member States, and the western Member States a much higher intensity than the eastern Member States, which display very low absolute levels of Business Expenditure in ICT R&D.

European public funding of ICT R&D is also significantly lower than elsewhere, and there are significant disparities between the Member States[71].

[68] PREDICT study report by EC/JRC/IPTS: http://ftp.jrc.es/EURdoc/JRC45723_RR.pdf.
[69] Report from the Groupement Français de l'Industrie de l'Information (GFII) to the Ministère de l'Éducation nationale, de l'enseignement supérieur et de la recherche (2007), http://www.recherche.gouv.fr/cid20858/analyse-statistique-des-investissements-en-r-d.html.
[70] 'The 2008 EU Industrial R&D Investment Scoreboard': http://iri.jrc.ec.europa.eu/research/scoreboard_2008.htm.
[71] PREDICT study report by EC/JRC/IPTS: http://ftp.jrc.es/EURdoc/JRC45723_RR.pdf.

The report from the Groupement Français de l'Industrie de l'Information (GFII) in the context of a study done for the CSTI (Conseil Stratégique des Technologies de l'Information), the Strategic Advisory Board on Information Technologies for the French Research Ministry (Ministère de l'Éducation nationale, de l'enseignement supérieur et de la recherche), provides data for 12 countries: 8 European countries (Germany, Spain, Finland, France, Italy, the Netherlands, the UK, Sweden), plus an estimated aggregated value for the EU-15, plus 4 other developed countries (the US, Canada, Japan, South Korea).

The data shows that public funds for ICT R&D accruing to US companies are almost four times bigger in the US than in Europe ($8 379m versus $2 399m PPP). This is mainly due to the importance in the US of defence-related R&D contracts of which a large share goes to ICT R&D. The report also shows wide variations between the Member States when it comes to the intensity and the leveraging effect of public funding on private investments.

1.19.2 Economic Analyses: EU-KLEMS[72]

ICT impacts on productivity through three main channels:

- Efficiencies are achieved through rapid technological progress in the production of ICT goods and services in ICT-producing industries. The ICT sector is thus a driver of productivity growth for the whole economy. Efficiency gains in the ICT sector are also reflected in the fast price declines of ICT products.
- Lower prices stimulate investments in ICT, providing more capital for workers and raising their productivity.
- Greater use of ICTs in all sectors in the economy helps firms to increase their efficiency.

These three effects do not occur simultaneously. Investments translate into efficiency gains only after a time lag, as ICTs are used to reorganise the production process. Therefore, the impact of ICTs on the wide economy is expected in two waves: in the short term, technological progress and reductions in the relative prices of ICT products increase investment; in the longer term, as the new technologies are adopted throughout the economy, new goods are developed and new modes of business organisation come into use.

Empirical evidence based on the growth accounting methodology and conducted in the framework of the Commission-funded EU-KLEMS project provides an estimation of the first two channels of ICT impact on productivity. In the period 2000-2004, they drove half a percentage point of productivity in the EU-15. Taking into account that, in the same period, productivity increased by a total of 1.1%, ICT accounted directly for almost 50% of it, in relative terms. In the same period, the US experienced much stronger productivity growth (2.8% on average) for which the ICT contribution was equal to 0.9% (32% in relative terms). In addition, this relative contribution of ICT to overall productivity growth has remained unchanged with respect to the previous 5 years (50% in the period 1995-2000). ICT thus contributed to 50% of overall productivity growth in the decade 1995-2004.

While a direct measurement of the third channel is not available, evidence for the period 2000-2004 shows that efficiency gains in the non-ICT sectors of the economy were negligible in the EU-15 economy, suggesting that EU businesses did not reap all the potential benefits from ICT take-up. In contrast, the US showed strong efficiency gains during the same period, which explained most of the difference in terms of overall productivity growth with respect to the EU-15. This is likely to be linked to the higher capacity of American enterprises to innovate their organisation and business processes so as to better exploit the take-up of ICT.

[72] EU-KLEMS: Productivity in the European Union: A Comparative Industry Approach: http://www.euklems.net/.

A narrower way to look at the economic effects of ICTs is to consider the contribution of the ICT industries (manufacturing and services) to productivity growth, without taking into account the investment in ICT by the rest of the economy. In the EU, during the period 1995-2004, the ICT industry drove about one fifth of the whole productivity increase. However, this contribution in the EU was lower than in the US, both because the size of the ICT sector is smaller (5.3% of GDP in the EU against 6.6% in the US) and because growth in efficiency gains in the EU ICT industries is less than in the US (5% against 6.2%).

1.19.3 Impact analysis of FP/IST domains[73]

The series of reports under the Framework Contract on 'Watching IST Innovation and Knowledge' is the result of studies being carried out to analyse the impacts of the activities funded by DG Information Society under the Fifth Framework Programme for Research and Technological Development (1999-2004). These studies provide a systematic and rolling process of data collection and analysis of the impact of completed IST R&D projects.

In the latest aggregate report, the outcomes of individual participations in FP5 are reviewed and weighed based on the results of a questionnaire survey to which over 3 000 participants responded. The main conclusions from the report were:

- The programme considerably strengthened the S&T knowledge and capabilities of both the R&D actors involved and the broader science and technology community, and promoted lasting research collaborations across Europe. The Community invested €3.4bn between 1998 and 2002 and funded a total of 2 500 projects. These projects were mainly direct research projects supplemented by a smaller number of supporting activities. The programme was divided into a number of Key Actions and Cross-Programme Actions and over the period involved over 8 000 organisations in nearly 18 000 participations.
- The research activities considerably influenced the latent capabilities of all stakeholder groups involved, thus improving their competitive advantage and facilitating innovation of their processes and/or product and service portfolio. The IST Programme triggered a large number of research activities in areas of high technical and/or commercial risk that could not have been implemented at corporate or national level alone.
- Major knowledge spillovers occurred to the broader scientific and technological community in the domains analysed, thus influencing research agendas of national programmes, creating or strengthening research communities, and ultimately strengthening Europe's competitiveness in R&D through the acceleration of S&T innovation.
- The strong support for the development of European and global standards in specific fields contributed to the strengthening of a coherent internal market. Numerous contributions were made to the political debate in relation to e-inclusion, environment management, digital rights management, and trust & security issues.

1.19.4 Europe Innova Synthesis Report[74]

The Sectoral Innovation Watch SYSTEMATIC project researches the factors and institutions impacting innovation performance and analyses the framework conditions for selected sectors including ICT. The main findings for the ICT sector were:

- The challenge for Europe's ICT sector is to continuously build upon its ability to develop frontier technologies and to facilitate the demand for them in potential leading markets within

[73] Impact Analysis of European ICT Research: http://cordis.europa.eu/ist/about/impact-analysis.htm.
[74] Europe Innova Synthesis Report: http://www.europe-innova.org/index.jsp?type=page&previousContentId=9741&cid=9942&lg=EN.

the context of the European social model. In order to strengthen the ICT industry and boost its competitiveness, the adoption of ICTs in all segments of the economy is important.

- ICT adoption in the public sector and public procurement are important drivers of innovation, the main challenge being to change the culture of public procurement to favour innovative solutions. Security issues and privacy concerns are important socio-cultural aspects which have a significant effect on innovation in the sector.
- ICT firms are faced with higher technological and economic risks in innovation while innovation expenditures consist mainly of intangible investment. They have to rely predominantly on internal financing or external equity financing to fund innovation. The problem of financing innovation therefore plays a particularly important role in the ICT sector and the venture capital market should be further expanded in this sector.
- An increase in the quantity and quality of both engineers and blue-collar workers in the ICT sector is important. The lack of mobility of people between departments and between the business and public sector is a challenge in the ICT industry. Entrepreneurship, project technology and business management skills should be added to the educational curricula.
- In many SMEs there is a lack of awareness of the potential of ICT, and these businesses also find it difficult to implement the necessary organisational changes in order to benefit from them.
- The European ICT market is still a fragmented market where national interests dominate. There is a need for a single internal market, both in production and in research. For the EU to cope with its relative decrease in world ICT production, a prospective innovation challenge lies in how to raise the awareness of its ICT products and services.

1.19.5 ERA Rationales Report[75]

As a precursor to the 'Ljubljana process' an independent expert group has since July 2007 been working on developing and expanding a rationale for an updated ERA. The key messages from the report were:

- While there is a pressing need to improve the effectiveness of the public research system, the ultimate justification of the resources and commitment needed to achieve this lies in increasing the value of the contribution that public and private sector research makes, and is seen to make, to Europe's economic, social and environmental goals.
- The central means to achieve this is to engage the research system in Europe's response to a series of 'Grand Challenges' which depend upon research but also involve actions to ensure innovation and the development of markets and/or public service environments.
- A research-friendly ecology is needed to allow actors and institutions to work together in productive networks. Sub-criticality in Europe at the level of research institutions inhibits their ability to configure themselves to address interdisciplinary problems and opportunities and to work well with business.
- A step change in the quality of dialogue and linkages between the supply of and demand for research is needed. A strategic re-orientation of applied research in Europe in close support of the full range of policies that Member States have agreed should be articulated at European level. This involves the Framework Programme and national programmes, linked through ERA-NETs and other instruments engaging much more effectively with policy needs in areas such as the environment, transport, energy, agriculture and health. Gaining full impact from these

[75] ERA Expert Group: 'Challenging Europe's Research: Rationales for the European Research Area (ERA)': http://ec.europa.eu/research/era/pdf/eg7-era-rationales-final-report_en.pdf.

recommendations will require that consideration be given to the effective allocation of responsibilities and procedures within Commission departments and Member States.

1.19.6 International programmes

R&D and innovation in ICT is de facto global and requires collaboration and competition beyond the EU's frontiers. The ICT strategies of international competitors must therefore be considered when developing a new ICT R&D and innovation strategy for Europe. A list of key reference documents is given below:

United States. One reference, among many, is the National Science Foundation's Investing in America's Future Strategic Plan FY 2006-2011[76].

Japan. The reference document is the 'New IT Reform Strategy'[77] issued in 2006 by the IT Strategic Headquarters of the Cabinet of the Prime Minister of Japan. This is followed by annual priority policy programmes.

China. The reference document is the 'National High Technology Research and Development Programme (863 Programme)'[78] from 2002 issued by the Ministry of Science and Technology of the People's Republic of China.

Taiwan. The National Science Council of the Republic of China (NSC) White Paper on Science & Technology (2007-2010)[79] and the 2007 e-Taiwan programme on the Ubiquitous Network Society[80] outlining the 2008 challenges.

India. One reference is the 'Information Technology Annual Report 2007-08'[81] issued by the Department of Information Technology of the Ministry of Communications and Information Technology. The same department also issued the report on the 'Information Technology Sector'[82] in the context of the Eleventh Five Year Plan 2007-2012.

South Korea. The main focus of the Korean government is to continue implementing their very ambitious 'IT 839 Strategy'[83], developed by the South Korean Ministry of Information and Communication (MIC). A new initiative for '22 Growth Engines' is currently being launched.

1.20 Policy communications

1.20.1 i2010 mid-term review[84,85]

The latest assessment of the Lisbon Strategy shows that structural reforms are starting to pay off, but the economic landscape is fragmented. This overall picture is also true for the information society. ICT continues to be a major driver of economic and social modernisation. Today, businesses in the EU devote 20% of investment to ICTs, 60% of basic public services are now fully available online, and more than half of EU citizens use the internet regularly.

While the 2007 Strategic Lisbon Report confirms the prominence of ICTs in structural reform and half of the Member States have strengthened their R&D and ICT policies, many parts of the EU still lag behind in adopting ICTs.

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[76] http://www.nsf.gov/pubs/2006/nsf0648/nsf0648.jsp.
[77] http://www.kantei.go.jp/foreign/policy/it/index_e.html.
[78] http://www.most.gov.cn/eng/programmes/programmes1.htm.
[79] http://web1.nsc.gov.tw/public/data/74141117271.pdf.
[80] http://www.etaiwan.nat.gov.tw/content/application/etaiwan/english/index.php.
[81] http://mit.gov.in/download/annualreport2007-08.pdf.
[82] http://planningcommission.nic.in/aboutus/committee/wrkgrp11/wg11_IT.pdf.
[83] http://www.mic.go.kr.
[84] http://ec.europa.eu/i2010.
[85] COM(2008) 199: 'i2010 Mid-term Review': http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0199:FIN:EN:PDF.

The i2010 mid-term review highlights the following issues as becoming more strategic for competitiveness and ICT take-up in Europe:

- Europe has made big progress towards the networked economy, but it needs to shift up a gear to lead the transition to next-generation networks while not slacking off in its efforts to overcome the digital divide.
- Europe should take better advantage of its number one economic asset, the largest consumer market in the developed world; however, despite the global spread of the internet, further steps are needed to create a single market for the digital economy.
- ICT research expenditure is still below target in most Member States. Greater efforts are needed to pool resources by coordinating research and innovation efforts.
- As the internet permeates daily life, public expectations and concerns about the information society are changing. Safeguards need to evolve to match technology and market developments, without stifling the huge opportunities that online social and economic activity offers.

1.20.2 ICT addressing socio-economic challenges

The third pillar of the i2010 policy framework for a 'European Information Society for growth and jobs' highlights the need to develop an inclusive information society and the importance of ICT for maintaining the quality of life for European citizens. Several activities have been carried out under this pillar and only the most recent policy communications are highlighted here.

e-Health provides the opportunity to maintain a high-quality and sustainable healthcare system in Europe despite growing pressure related mainly to the ageing society and the rising costs of managing chronic diseases. The European e-Health Action Plan[86] aims to allow the EU to provide better access and better services as well as to assess the impact of e-health on the overall productivity of the healthcare sector. The actions range from research to uptake and roll-out.

The most recent Communication on e-Inclusion[87] proposes an e-inclusion campaign to raise awareness and connect efforts as well as a strategic framework to implement the Riga Ministerial Declaration[88]. This includes addressing the need of older workers and people to be active in the information society, reducing the geographic divide, enhancing e-accessibility, improving digital literacy and promoting cultural diversity and promoting inclusive e-government.

Countries that score high on public sector efficiency and effectiveness are also at the top of economic performance and competitiveness scoreboards. The eGovernment Action Plan[89] aims to increase the efficiency and openness of public administrations in Europe, helping them to meet today's challenges and citizens' demands. The action plan focuses on the objectives of secure and authenticated access to public services, and inclusion of all citizens. The ISA programme[90] will be based on the achievements of the IDA and IDABC programmes and will, as its predecessors, contribute to the further development and implementation of the European eGovernment strategy.

The Communication on ICT for energy efficiency[91] raises awareness of the current and potential impact of ICT as an enabler for energy efficiency. The Communication has speeded up the debate among stakeholders on priority areas for action such as the power grid, smart buildings, smart

[86] COM(2004) 356: 'eHealth Action Plan': http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2004:0356:FIN:EN:PDF.
[87] COM(2007) 694: 'European i2010 Initiative on e-Inclusion: To be part of the information society': http://ec.europa.eu/information_society/activities/einclusion/docs/i2010_initiative/comm_native_com_2007_0694_f_en_acte.pdf.
[88] 'Riga Ministerial Declaration': http://ec.europa.eu/information_society/events/ict_riga_2006/doc/declaration_riga.pdf.
[89] COM(2006) 173: 'eGovernment Action Plan': http://ec.europa.eu/idabc/servlets/Doc?id=25286.
[90] COM(2008) 583: "Interoperability solutions for European public administrations (ISA)"
[91] COM(2008) 241: 'Addressing the challenge of energy efficiency through ICT' :http://ec.europa.eu/information_society/activities/sustainable_growth/docs/com_2008_241_1_en.pdf.

lighting and ICT itself. The results of this debate together with proposals for actions will be presented in a second communication planned for the first quarter of 2009.

The Intelligent Car Initiative[92] aims to increase road safety in Europe and cut the greenhouse gas emissions caused by road transport, through the use of intelligent ICT systems in cars. The most recent Communication[93] reports on progress made under the Initiative by the Member States and the EU and highlights where more efforts still are needed.

The importance of ICT to the European economy has increased the demand for highly skilled ICT practitioners and users as well as the need to combat digital illiteracy. A number of recommendations have been made and adopted by Member States in the Thessaloniki Declaration[94]. These include the need for a long-term agenda on e-skills for workforce development and competitiveness; enhanced public-private cooperation to ensure a seamless framework between basic training and professional development; and public-private partnerships to raise the image and attractiveness of ICT jobs and careers. The recent e-Skills Communication[95] proposes specific actions at EU and national levels needed to implement these recommendations. Focus should be not only on the lack of students and researchers at tertiary education level, but also on the lack of digitally skilled users coming out of the education system at earlier levels and the lack of incentives for them to continue towards an ICT-oriented career.

Digital competences have become an essential element in the education of individuals, and this in a context of lifelong learning. The education systems must integrate ICT in pupils' courses, teachers' training and teaching methods[96]. The Commission Staff Working Document on the 'Use of ICT for supporting innovation and lifelong learning for all' reports on the progress made and proposes a renewed approach towards the role of ICT in education and training as an enabler of lifelong learning and a driver for creativity and innovation. More should be done to increase levels of confidence of learners, upgrading digital competences and to shift from access to quality of use of ICT for learning[97].

1.20.3 Innovation policy[98]

The 2006 Aho Group[99] proposed that the EU innovation strategy be focused on the creation of innovation-friendly markets, strengthening R&D resources, increasing structural mobility, and fostering a culture that celebrates innovation. In particular, the Aho Group called for large-scale strategic actions in key sectors to provide an environment in which supply-side measures for research investment can be combined with the process of creating a demand and a market.

In response to the Aho Group, the Communication on 'Putting knowledge into practice: A broad-based innovation strategy for the EU'[100] pointed the way forward to accompany industry-led and society-driven innovation with competitiveness and public policies at all levels as a core element of the Lisbon strategy for growth and jobs.

Several follow-up communications have been issued which all contain important elements for the ICT area:

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[92] 'i2010 Intelligent Car Initiative': http://ec.europa.eu/information_society/activities/intelligentcar/index_en.htm.
[93] COM(2007) 541: 'Towards Europe-wide Safer, Cleaner and Efficient Mobility: The First Intelligent Car Report': http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0541:FIN:EN:PDF.
[94] European e-skills 2006 conference: http://www.e-scc.org/docs/Thessaloniki_Declaration_2006.pdf.
[95] COM(2007) 496: 'e-Skills for the 21st century': http://ec.europa.eu/enterprise/ict/policy/ict-skills/2007/COMM_PDF_COM_2007_0496_F_EN_ACTE.pdf.
[96] Presidency of the European Union Council, Ministerial conference on e-inclusion, 2 December 2008
[97] COM: New skills for New Jobs; SEC(2008) 2629 The use of ICT for supporting innovation and lifelong learning for all
[98] COM(2006) 502, EU Innovation Policy, http://ec.europa.eu/enterprise/innovation/index_en.htm.
[99] Aho Group: 'Creating an Innovative Europe', 2006: http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm.
[100] COM(2006) 502: Putting knowledge into practice: A broad-based innovation strategy for the EU: http://www.europe-innova.org/exportedcontent/docs/6/6206/en/EN%20502%20-%20original.doc.

The Communication on the Lead Market Initiative[101] proposes an approach to foster the emergence of markets for innovative goods and services based on anticipatory and concerted action to remove the barriers that block the emergence of strong demand. The Communication also identifies promising emerging markets to be supported by such an approach: e-health, protective textiles, sustainable construction, recycling, bio-based products and renewable energies. For e-health, the focus is on (1) reducing market fragmentation and lack of interoperability through pilots, benchmarking, standardisation and certification; (2) improving legal certainty and consumer acceptance by disseminating information, best practice, guidelines, recommendations and implementing screening tools; (3) facilitating access to funding through increased visibility and training, workshops, improved cooperation, testing & pilots and guidance on financing; and (4) improving procurement by facilitating the expression of public demand through more innovation-friendly procurement activities.

The Communication on Pre-Commercial Procurement[102] addresses the need for more innovation in the public sector and provides an approach to procure R&D services. It launches a debate on which areas could lend themselves to the approach presented for pre-commercial procurement. The Communication explores the extent to which pre-commercial procurement could indeed contribute to more R&D and innovation in the EU. The approach provides for risk/benefit sharing between private and public players, and collaborations between public procurers to allow for economies of scale especially in fast moving markets.

The European Institute of Innovation and Technology (EIT) is a European initiative aiming to integrate the three sides of the 'knowledge triangle': higher education, research, business-innovation. The mission of the EIT is to explore excellence in entrepreneurship education, research and business for world class innovation. With a view to making the EIT operational, a top priority for its Governing Board is the selection of the first Knowledge and Innovation Communities (KICs) by January 2010. KICs are highly integrated partnerships composed of businesses, entrepreneurs, universities, research institutes and technology centres that will produce new innovation models and inspire others to emulate them.

Strengthening clusters in Europe has also been identified as one of the strategic priorities for successfully promoting innovation. Clusters play an important role in driving competitiveness, innovation and job creation. The recent Communication on Clusters[103] strives towards a more efficient framework for the development of world-class clusters in the EU. Clusters should be open, flexible and attractive to the best talent and expertise available worldwide. Efforts at regional, national and EU level should facilitate the establishment of closer and more efficient linkages between clusters as well as with leading research institutes within Europe and abroad. At the same time, cluster organisations are invited to improve their support services and better integrate innovative SMEs.

In a highly competitive global economy, improved access to financing for innovative SMEs has become more important to enhance their competitiveness. The fragmentation of the European venture capital markets along national lines seriously limits the overall supply of early-stage capital. In Member States where the market is new, venture capital funds face problems reaching the critical mass they need to spread their portfolio risk and cover their costs. The 2007 Communication on cross-border investments by venture capital funds[104] invites the Member States to enable cross-border operations and consider mutual recognition of venture capital funds. A better regulatory

[101] COM(2007) 860: 'A lead market initiative for Europe': http://ec.europa.eu/enterprise/leadmarket/doc/com_07_en.pdf.
[102] COM(2007) 799: 'Pre-commercial Procurement': http://ec.europa.eu/invest-in-research/pdf/download_en/com_2007_799.pdf.
[103] COM(2008) 652: 'Towards world-class clusters in the European Union': http://ec.europa.eu/enterprise/innovation/doc/com_2008_652_en.pdf.
[104] COM(2007) 853: 'Removing obstacles to cross-border investments by venture capital funds': http://ec.europa.eu/enterprise/entrepreneurship/financing/docs/COMM_PDF_COM_2007_0853_F_EN_ACTE.pdf.

framework will lower operational costs and risks, raise returns, increase the flow of venture capital and improve the functioning of venture capital markets.

With the European Small Business Act[105] the Commission proposes a genuine political partnership between the EU and the Member States recognising the central role of SMEs in the EU economy. The Small Business Act sets in place for the first time a comprehensive policy framework for the EU and its Member States. At the heart of the SBA is the conviction that achieving the best possible framework conditions for SMEs depends first and foremost on society's recognition of entrepreneurs, including crafts, micro-enterprises, family-owned or social economy enterprises, and making the option of starting one's own business attractive.

With the European Year of Creativity and Innovation in 2009[106], the Commission emphasises the importance of education and training as one of the three sides of the knowledge triangle for increasing both competitiveness and social cohesion. Creativity and innovation mindsets have to be triggered and developed as early as possible in the lifecycle and should be emphasised in education and training.

1.20.4 ERA policy[107]

Taking into account the results from the 2007 public consultation on the ERA Green Paper[108] and building on ongoing work, five new ERA initiatives were launched in 2008. These new initiatives address researchers' careers and mobility, research infrastructures, knowledge sharing, joint programming in research, and international science and technology cooperation.

- The Commission Communication on 'Better careers and more mobility: A European partnership for researchers'[109] proposes that Member States endorse common and mutually reinforcing objectives in the field of careers and mobility of researchers and recognises that these aims should be taken forward in an effective and balanced partnership complying with the principle of subsidiarity. The partnership will aim to speed up progress in key areas including social security, competition-based transnational recruitment and portability of funding, employment and working conditions and training and skills. The Competitiveness Council of 26 September 2008 welcomed the Communication.
- The Regulation on European research infrastructures[110] provides a legal framework to assist Member States to develop and fund pan-European research infrastructures which their national legal instruments might not be able to facilitate. It is an important new tool for taking forward the ongoing work of ESFRI. ESFRI's aim is to support a coherent and strategy-led approach to policymaking on research infrastructures in Europe, and to facilitate multilateral initiatives leading to the better use and development of research infrastructures, at EU and international level.
- On 9 April 2008 the Commission adopted a Recommendation on the management of intellectual property rights in knowledge transfer activities and a Code of Practice for universities and other

[105] COM(2008) 394: 'A "Small Business Act" for Europe': http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0394:FIN:EN:PDF.
[106] COM(2008) 159: 'European Year of Creativity and Innovation (2009)': http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0159:FIN:EN:PDF.
[107] European Research Area (ERA): http://ec.europa.eu/research/era/index_en.html.
[108] 'The European Research Area (ERA): New Perspectives (Green Paper)': http://ec.europa.eu/research/era/pdf/era-greenpaper_en.pdf.
[109] COM(2008) 317 final: 'Better careers and more mobility: a European Partnership for researchers': http://ec.europa.eu/research/press/2008/pdf/com_2008_31_1_en.pdf.
[110] COM(2008) 467: 'Community legal framework for a European Research Infrastructure (ERI)': http://ec.europa.eu/research/press/2008/pdf/com_2008_467_en.pdf.

public research organisations[111]. The objective is to facilitate and promote the optimal use of intellectual property created in public research organisations to increase both knowledge transfer to industry and the socio-economic benefits resulting from publicly funded research. The Recommendation includes a Code of Practice to promote the professional management of intellectual property in the European Research Area within research organisations and to become a reference for cooperation and/or negotiation between research organisations and industry. The Commission Recommendation was supported by a Council Resolution adopted on 30 May 2008[112].

- The Communication on Joint Programming[113] sets out a new approach for making better use of Europe's limited public R&D funds through enhanced cooperation. The Competitiveness Council adopted Conclusions on Joint Programming in December 2008. The objective is to develop a more strategic and better structured approach to future joint programming between Member States, allowing groups of countries or regions to combine their efforts and build critical mass that would not be possible for individual programmes in areas of strategic importance for solving societal problems or improving competitiveness. Joint Programming offers a voluntary process for a revitalised partnership between the Member States based on clear principles and transparent high-level governance.
- The Communication on International S&T cooperation[114] proposes a common policy framework for both the Community and Member States to foster and facilitate coherent international science and technology cooperation activities. It also covers the specific aspects of such cooperation in ICT. The Competitiveness Council adopted Conclusions on the framework in December 2008. Cooperation based on mutual benefit with third countries is crucial to the Community's scientific, political and economic objectives.

All five initiatives aim to establish lasting partnerships with Member States and stakeholders — including businesses, universities and research organisations — to develop the ERA jointly in their specific areas of focus. This so-called 'Ljubljana Process' of effective governance of the future development of ERA also includes agreement on a common long-term vision for the future of ERA 2020. This vision will form the basis for future actions and initiatives and contribute to better governance, in particular improved political steering at the ministerial level. It highlights the importance of ERA being rooted in society and the global economy, of achieving competitiveness and excellence for businesses and R&D, and of free circulation of knowledge.

1.20.5 Regional policy[115]

The focus on research and innovation in EU cohesion policy has increased remarkably in recent years. The Community strategic guidelines on cohesion policy[116] (2007-2013) stress that to promote sustainable development and strengthen competitiveness it is essential to concentrate resources on research and innovation, entrepreneurship, innovative ICT and human capital (training and adaptability of workers). This evolution is documented both in the staff working paper 'Regions

[111] C(2008) 1329: 'Commission Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations': http://ec.europa.eu/invest-in-research/pdf/ip_recommendation_en.pdf.
[112] Council Resolution on the management of intellectual property in knowledge transfer activities and on a Code of Practice for universities and other public research organisations (10323/08): http://register.consilium.europa.eu/pdf/en/08/st10/st10323.en08.pdf.
[113] COM(2008) 468: 'Towards joint programming in research': http://ec.europa.eu/research/press/2008/pdf/com_2008_468_en.pdf.
[114] COM(2008) 588: 'A strategic European framework for international cooperation in science and technology (S&T)': http://ec.europa.eu/research/press/2008/pdf/com_2008_588_en.pdf.
[115] EU Regional Policy: http://ec.europa.eu/regional_policy/index_en.htm.
[116] COM(2005) 299: 'Cohesion Policy in Support of Growth and Jobs: Community Strategic Guidelines, 2007-2013': http://ec.europa.eu/regional_policy/sources/docoffic/2007/osc/050706osc_en.pdf.

delivering innovation through cohesion policy'[117] as well as in the Communication on 'Competitive European Regions through Research and Innovation: A contribution to more growth and more and better jobs'[118].

To address the new challenges facing the EU the Communication calls on Member States and regions to make more effective use of the EU research, innovation and cohesion policies and instruments. It highlights that regional clusters are often the key to the successful promotion of research, technological development and innovation encouraged by physical proximity of all actors. The capacity of regional decision-makers and entrepreneurs to turn knowledge, skills and competencies into sustainable competitive advantage is crucial to regions' economic performance. However, the capacity to absorb and develop knowledge and technology varies widely across European regions, impeding their growth prospects and reinforcing disparities in prosperity.

The planned investments by Member States and regions for research and innovation, entrepreneurship, innovative ICT and human capital in the period 2007-2013 is expected to be above €83 billion, which corresponds to 25% of the total new envelope for the 27 Member States. It is interesting to note that the value for the EU-15 is more than €48 billion; corresponding to 30% of the total, while for the EU-12 it is €35 billion, or 20% of the total. This is more than three times higher than in 2000-2006 where investments in these types of projects reached €25 billion. For innovative ICT projects the planned investments in 2007-2013 are €13 billion, against €7 billion in 2000-2006.

[117] SEC(2007) 1547: 'Regions delivering innovation through cohesion policy': http://ec.europa.eu/regional_policy/sources/docoffic/working/doc/SEC-2007-1547.pdf.
[118] COM(2007) 474: 'Competitive European Regions through Research and Innovation': http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0474:FIN:EN:DOC.

ANNEX II: EXAMPLES OF EUROPEAN-SCALE PROJECTS

1.21 Personalised healthcare against chronic diseases

Europe is going though a major demographic change that will affect both the economy and healthcare systems. The prevalence of chronic diseases will rise, leading not only to more people with compromised health, but also to lost productivity due to prolonged absence or reduced capacity of the workforce. Our healthcare systems are currently ill-equipped to cope with the pressure caused by the increased incidence of chronic diseases. ICT offers solutions, in the form of personalised care and tools that enable individuals to manage their own health: firstly, by facilitating new ways to manage chronic diseases, based on remote self-care outside traditional healthcare institutions; and secondly, by supporting prediction and prevention of diseases to avoid costly and unpleasant treatments. Both these directions need to be pursued in an orchestrated manner, to meet the challenge of providing sustainable, high quality healthcare and privacy friendly.

A holistic 'umbrella' approach is required, encompassing in a large-scale action the full innovation chain, from fundamental research and technological development to support for uptake and deployment. For instance, prediction and prevention of diseases require the development of complete disease simulators and models of the human body at different levels (e.g. cellular and organ), which in turn necessitate research in domains such as mathematics and engineering to link models from different levels. Efficient chronic disease management involves the development of precise and reliable devices for monitoring health status and offering personalised treatment. Research is also needed for putting in place the necessary ICT infrastructure to facilitate access to medical knowledge, analysis of data and implementation of services for exchanging information among actors in healthcare, while respecting privacy and protection of personal data. In fact, the coordination and continuity of care are among the major areas that can benefit from ICT applied to healthcare. A crucial element is the development and validation of new care processes at local/regional/national/cross-border level, as well as business models for device manufacturers, the pharmaceutical industry, service providers and public/private insurers. In parallel, patient-centeredness and the active participation of citizens and health professionals in the development, validation and use of eHealth tools, is key to the success of implementation. Such deployment-related activities will also feed back to the innovation chain, identifying further areas where focused research is required.

A large-scale European project in the domain of ICT for health will help achieve impact on individuals, healthcare systems and the market. The latter comprises three major segments in Europe: pharmaceuticals, medical technology and e-health, with significant market sizes of €205bn [119], €64bn [120] and €20bn [121] respectively. Products and services employing portable or wearable systems such as 'biomedical clothes' or artificial organs will be made available for remote treatment and management of e.g. heart and kidney failure. Predictive and preventive tools will become mainstream in healthcare, also for testing new drugs and suggesting treatment for conditions such as cancer and musculoskeletal diseases. Importantly, Europe will be able to establish 'the CERN for the Virtual Physiological Human' — a virtual centre of excellence that will provide advanced R&D platforms for integrative biomedical research, support and guidance for testing and validating models and tools in clinical practice, as well as strong innovation and exploitation support.

[119] EFPIA.
[120] Eucomed.
[121] eHealth Industry Stakeholder's group.

1.22 ICT for energy-positive buildings and neighbourhoods

Energy-positive buildings and neighbourhoods are those that generate more power than their needs. They include the management of local energy sources (mainly renewable, e.g. solar, fuel cells, micro-turbines) and the connection to the power grid in order to sell energy if there is excess or, conversely, to buy energy when their own is not sufficient. They are equipped with intuitive devices that not only meter the energy consumed but also provide real-time information (e.g. on incentive pricing, deviations from standard consumption) to help people living in (or managing) these environments save energy while maintaining the desired comfort levels. They include plug-in hybrid electric vehicle infrastructures in order to facilitate not only clean transport but also alternative local energy storage.

In order to achieve energy-positive buildings and neighbourhoods, much innovation in ICT is need. Examples are: decentralised monitoring and control systems for power quality management, communication protocols, power electronics, e-trading platforms for dynamic pricing, virtual power plants, multi-agent systems, service architectures. Some of these technologies are mature; others are in the early stages of development and some are still to be researched.

A coordinated effort under one umbrella project (involving R&D, pilots, training, feasibility studies and deployment) would aim to develop further and implement innovative solutions so as to achieve ambitious targets, for example reducing energy consumption by 30% in five years. To ensure technology acceptance, and to avoid market fragmentation, this umbrella project would be established with the support of local/regional authorities from the different European climate regions.

1.23 A multi-faceted electronic identification (eID) system for all citizens

Proper identity management in the future digital society is of crucial importance for trustworthy interactions between public authorities, businesses, citizens, and within the large spectrum of social networks and communities. It is the basis for trustworthy services and interactions in domains such as e-government, e-health, e-commerce, finances, web 2.0 communities, and the internet of things encompassing virtual and tangible entities. A ubiquitous eID infrastructure for digital life needs to be anchored on the EU-wide adoption of a multi-faceted trustworthy electronic identity management infrastructure for all citizens that will work throughout all domains of the information society providing multiple identity instances, from government-accredited to commercially accepted, and ranging from near-anonymity to strong and unambiguous identification. This should start from a user-controlled and privacy-protective perspective and provide the basis for accountability and innovative applications in an open and competitive market.

Responding to the diverse needs for identity management in the above-described domains, we have in recent years seen the appearance of a plethora of solutions, some more mature than others and some addressing their specific stakeholders only, resulting in fragmentation, lack of interoperability, closed solutions, privacy breaches, and lack of user control, transparency and accountability. Currently a number of major European initiatives in the domain of digital identity management are ongoing (for example the STORK pilot project and the substantial user-centric digital identity management activities in the FP6 IST and FP7 ICT programmes). The practicality of these innovative eID approaches and interoperability solutions are still to be determined and the need for a formal legislative basis for EU-wide interoperability of eID tokens has to be clarified. Additional R&D is required for trustworthy identity and privacy management, and for security technology protecting relevant data and communication (see the ICT and Security programmes). A concerted, anticipatory approach — under one umbrella and as public-private partnerships — should enable the development of relevant frameworks, standards and technologies for the procurement and deployment of an interconnected eID infrastructure across Europe.

ANNEX III: GLOSSARY

AAL	Ambient Assisted Living
ARWU	Academic Ranking of World Universities
BERD	Business Expenditure on R&D
CIP	Competitiveness and Innovation Programme
CLWP	Commission's Legislative Work Programme
CSTI	Conseil Stratégique des Technologies de l'Information
EC	European Commission
ECFIN	Economic and Financial Affairs Directorate-General
eID	Electronic Identification
EIT	European Institute of Innovation and Technology
EGEE	Enabling Grids for E-sciencE — world's largest multi-disciplinary grid infrastructure
ERA	European Research Area
ERA-NET	European Research Area Network
ERI	European Research Infrastructure
ESFRI	European Strategy Forum for Research Infrastructures
ETP	European Technology Platform
EU	European Union
EU-15	Member States of the EU prior to the accession of ten countries on 1 May 2004
EUREKA	Pan-European network for market-oriented, industrial R&D
EVCA	European Venture Capital Association
FP5	5th EU Research Framework Programme for Research and Technology Development
FP6	6th EU Research Framework Programme for Research and Technology Development
FP7	7th EU Research Framework Programme for Research and Technology Development
GDP	Gross Domestic Product
GÉANT	A multi-gigabit pan-European data communications network for research and education
GERD	Government Expenditure on R&D
GFII	Groupement Français de l'Industrie de l'Information
ICT	Information and Communication Technologies
ICT PSP	ICT Policy Support Programme
IPR	Intellectual Property Rights
IST	Information Society Technologies
ISTAG	ICT Advisory Group
JNP	Joint National Programme
JRC/IPTS	Institute for Prospective Studies at the Joint Research Centre
JTI	Joint Technology Initiative
KIC	Knowledge and Innovation Community (EIT)
PC	Personal Computer
PPP	Purchasing Power Party
R&D	Research and Development
R&D&I	Research and Development and Innovation
SBA	Small Business Act
SME	Small and Medium-sized Enterprise
S&T	Science and Technology
UK	United Kingdom
US	United States
VC	Venture Capital