Self-Assessment of the Effectiveness of IST-RTD in the 6th FP

Ex-post Evaluation of
the IST Research in FP6

6 DECEMBER 2007

Foreword

This Self-assessment of the effectiveness and impacts of Information Society Research and Technology Development in the 6th FP (2003-2006) reflects the information available to the staff of DG-Information Society and Media (DG INFSO). It summarises data, knowledge and experiences relevant to the issues addressed by the Panel established for the ex-post evaluation of this EU-support to RTD.

Fuller assessments by each Directorate of DG INFSO responsible for part of the IST thematic priority are also available, and have provided the substance and examples in this summary.

The views expressed are those of the Officials in DG-INFSO directly involved with the management of IST-RTD and do not necessarily reflect those of the European Commission.

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Executive Summary

The ICT-sector continues to make the largest investment in research and innovation, worldwide and in Europe. ICT-based innovations continue to be the main driver of growth in the US and to a lesser extent the EU, and of new service and employment growth worldwide.

Support for IST-RTD was a major part of the collaboration and infrastructure actions of the 6th FP, and the main element in the 2nd pillar of the i2010 policy framework for development of an information society in Europe: a key support to innovation in the Lisbon strategy for growth and jobs. The objectives of the 6th FP were to strengthen the European Research Area and the scientific and technological basis of European Industry, and to promote research activities in support of other EU policies. The objective of the IST thematic priority was to ensure leadership in these technologies, increase innovation and competitiveness and to ensure that developments benefit all European citizens.

This assessment focuses on the strategic impacts; efficiency and simplification in management; the effectiveness of the interventions; their utility and the continuity of impacts.

Strategic Impact

The strategic impact and relevance of IST has been maximised by focusing on some areas where Europe can create and sustain world leadership; on strengthening collaboration in the European research area, and on exploiting the results in the context of policy initiatives in the i2010 framework.

Europe has sustained world leadership in several areas. The 6th FP has reinforced leadership, and opened opportunities for new entrants, notably SMEs. Leading companies continued to participate, and technology performance achievements are still ahead of comparable developments elsewhere in these areas. European researchers and companies continue to lead developments in key technology areas.

Support to "future and emerging technologies" has created leadership in some new areas: numerous prestigious prizes were awarded to European researchers and multi-disciplinary RTD on nano-scale and molecular electronics is at the forefront of research in the world, again with international awards.

IST-RTD has made a major contribution to strengthening the European Research Area. They have brought together over 4500 industrial and academic partners: Companies and academia have been better able to transfer new ideas from research into practice. The clustering of projects and European Technology Platforms have extended cooperation beyond the individual projects, and fostered wider synergies. Collaboration across Europe was more intense and more complete in the 6th FP than in previous FPs. A strong set of Integrated Projects and Networks of excellence brought together most key RTD players. The major national research centres in Member States participated. IST-RTD was effective in linking universities and businesses; connecting different themes and disciplines; and in integrating New Member States, patent holders and SMEs.

The collaboration has been extended by stronger links to the major EUREKA clusters and at the national level and by stimulating collaboration in European Technology

Platforms: IST-RTD has enabled creation of 9 European Technology Platforms, each of which has agreed a Strategic Research Agenda. Two of these have already provided the basis for proposed Joint Technology Initiatives, which can lighten management in specialised bodies, as well as leveraging more Member State and private funding into a coherent framework. Collaboration has been broadened by other frameworks and in various standardisation frameworks and business associations. The European network of Living Labs, is an example of new collaboration between different stakeholders. Creation of the Forum of National ICT Directors strengthened national collaboration; ERA-Net actions in the 6th FP have been valuable, and the proposed joint initiative under Article 169 will help. More generally, support to research networking now enables collaboration by over 60 million researchers, with world-leading capacity and coverage, enabling new forms of "Virtual Research Communities" to emerge.

Participation of SMEs has also been sustained at over 20% (20.7%); significantly greater that the 15% target. SMEs participating in IST-RTD patent more than most. However, only about 5% of those with the most highly cited ICT patents have participated. High-tech SMEs are still not fully involved, probably due to the duration of projects and lack of incentives. They depend on rapid market introduction of new products and services, and multi-annual research may often not be attractive. The 6th FP has also **opened up new markets for SMEs in some areas**

The IST-RTD has been a strong foundation for i2010 policy initiatives: 34 policy initiatives have been launched by the European Commission during 2004-7 The IST research has also contributed to **the regulatory proposals, notably to the reform of eCommunications regulations.**

IST research has contributed to policy initiatives led by other DGs in the Commission: An "information society policy-link" has strengthened links across the Commission: It has highlighted 2500 projects with concrete results relevant to policies on the environment, security, employment and regional policy. IST-RTD has also complemented EU-Development projects to extend research networks to North Africa, Latin America and Asia, and to extend their use to schools and the eHealth community.

Integrated Projects in the 6th FP have Strengthened International co-operation and attracted most global innovation leaders. Through them, the European RTD community is well linked to broader global RTD and innovation, and is able to feed into, and draw from innovations in the US and Asia, and to benchmark achievements worldwide. **Co-operation with China, India and Africa, has also been strengthened**:

Efficiency and simplification

The IST thematic priority, as decided by the Council and Parliament, has been implemented on schedule. Eight calls for proposals were published. 7,110 proposals were evaluated, and 1,171 projects were funded. The execution of the budget was as targeted. Electronic submission of RTD proposals reduced the burden on proposers, enabled them to more easily format their proposals, and speeded up evaluations.

The evaluation of proposals is now efficient and robust and all were completed on schedule. They were monitored by independent experts, and their recommendations were followed up. Strong competition for EU funding **ensured a high scientific quality in funded projects:** few under-perform, and most deliver good scientific and technological work Further improvements could be made, notably through remote

evaluation and a more streamlined structure of proposals: These are being implemented in the 7th FP.

The efficiency of reaching "grant agreements" has been improved. Project management in DG-INFSO is now fully electronic, with full integration of the IT systems for contract generation, management, and payment.

The rules for participation and "grant agreements" were satisfactory: somewhat better than for the 5th FP. They presented some difficulties on sub-contracting, and "joint financial liability", and for the "open source" community, and complexities were a barrier to first-time SME participants. However, the agreement did not provide sufficient assurance on the real costs incurred, and a requirement of **"Audit certificates"** was therefore introduced for all participants and all payment periods. These were found to be of limited value, and a disproportionate administrative burden. The requirement was therefore waived for smaller organisations during the latter part of the 6th FP. The Grant Agreement was complemented with a consortium agreement, and industry-led projects generally have good agreements. However, it remains important that proposers reach fair agreements before signing the grant agreement.

The understanding and effectiveness of the new instruments has improved through the 6th FP. They presented a challenge, both in the Commission and to stakeholders. Initially expectations for Integrated Projects (IPs) were difficult to meet. However, most proposed IPs in the later phases were consistent with the budget capacities. This instrument is now effective in assembling critical mass, involving key stakeholders and in system validation. The Network of Excellence (NoE) concept was not initially well understood. Many early proposals simply strengthened coordination with no lasting integration. However, most of the funded Networks have increased coherence, although they remain difficult to manage, and were used less in later calls. Most contribute to community building and catalyse co-funding at national level. However, Co-ordination Actions were a lighter and more flexible instrument for similar purposes.

The administrative burden associated to a proposal or project in the 6th FP was heavier that for previous frameworks, contrary to the Commission's intentions. This was the result of the rules for participation; the unfamiliarity of the new instruments; the large numbers of partners in IPs and NoEs, and some aspects of the way the new instruments were implemented. However, with the new instruments, the total number of projects was reduced by a factor of 2.5 compared with the 5th FP, with a similar management overhead per project. **The overall burden of administration has therefore significantly reduced from both the Commission and participants' perspectives**. Further simplifications have been achieved in the 7th FP.

Effectiveness

Support for IST-RTD was implemented by open calls for RTD proposals against published work-programmes, which defined priorities, instruments and evaluation criteria. Three work programmes were adopted: for 2003-4, for 2005-6 and in 2006. **They remained relevant to scientific and technological developments elsewhere.** Their development was supported by workshops, technology road-mapping, SWOT and portfolio analyses. They focused on building European strengths, opening new business opportunities, combating weaknesses, and making applications accessible to all. They promoted a user-centred, systemic approach, and reflected advice from the IST Advisory Group, the IST programme Committee, from the previous evaluations and impact

assessments and input from European Technology Platforms. They were in line with both mainstream and emerging R&D directions and with the specification of the IST thematic priority. Independent verification of the relevance of work-programmes is available in some areas.

In most cases, the objectives of the thematic priority and work-programmes have been met. IST-RTD projects will continue to generate new knowledge for several more years: Only half the funded projects will be finished by the end of 2007. Most will increase European capabilities in development and use of innovative products and services. Current trends in internet service-use, Web 2.0, networked business processes, digitization, and creativity reinforces the probability of high take up and commercial exploitation of the research outcomes. An "Impact Analysis Observatory" operated run by external experts is analysing the impacts of projects in the 5th FP and will address those from the 6th FP from 2008.

Achievements have been widely reported and publicised: Over 18,991 scientific publications and 511 patent applications were reported in 2005 and 2006, and an on-line service has produced 1,500 feature articles and 3,600 news items from the 2,000 active projects. Its website receives 100,000 visits and 240,000 page-views per month. Collaboration with EuroNews on the Futuris magazine has covered 30 topics, 10 exclusively on ICT, and reaches over 1 million viewers.

There **have already been major achievements at the systemic level**: Europe's position has been strengthened in standardisation bodies and fora. This will help avoid market fragmentation and give European companies a leadership opportunity in global markets. Contributions to international frameworks and standardisation bodies are now vital to European leadership in new global markets. The number of such bodies has increased enormously during the 5th and 6th FPs

Research also opens up new areas for investigation and development

Utility

Much of the benefit of support to RTD has been in strengthening co-operation between companies and academia in pre-competitive RTD, and in involving suppliers and users in technology integration at the EU-level **that would otherwise not have been possible**.

The combination of disciplines in some larger integrated projects has also generated **unexpected innovations**: for example, in low-power Bluetooth communication, and in "flexible electronics"; in the emergence of a common vision of the convergence of mobile, wireless and broadband communications, or in the emergence of "computational science" as a contributor to informed decisions on complex problems in sustainable development, public health and national security.

Continuity of Impacts

Most participants report major benefits in new knowledge, skills and contacts for collaboration. **This increased human capital persists**: the experience and knowledge is retained through the subsequent careers of the scientists and engineers. Co-operation networks in specific areas also persist and become the core of wider collaborations, such as in the European Technology Platforms. Establishment of Institutes and Associations emanating from NoEs will continue to operate after the end of funding.

However, there is a danger that coherence will be lost if EU-RTD is not maintained in some areas. Without EU intervention, it is possible that access to new ideas will become the privilege of a handful of large organisations; the European dimension would be lost, and the flow of new ideas from academia to industry would be compromised. The 6th FP has provided framework for cooperation across a range of stakeholders who individually do not have the resources or the competence to address all aspects of ICT systems

1. CONTEXT

1.1. The 6th Framework Programme in the context of the evolution of EU support to Research and Technology Development (RTD).

The 6th Framework Programme[1] (6th FP or FP6) brought together all the different lines of research pursued by the European Union from 2003 until 2006.

The primary objective of the 6th FP was to further the objective of Community research and development Framework programmes as set out in Article 163(1) of the EU Treaty that is *"strengthening the scientific and technological bases of Community industry and encouraging it to become more competitive at international level, while promoting all the research activities deemed necessary by virtue of other Chapters of the Treaty"*.

FP6 was then structured around three pillars:

– Focusing and Integrating Community research

– Structuring the European Research Area

– Strengthening the foundations of the European Research Area.

The bulk of expenditure under the 6th Framework Programme was on major collaborative research projects that were structured so as to have an integrating effect on Europe's research resources. The research themes were selected in the light of political debate, expert advice, and public consultation.

Information Society Technologies (IST)-RTD in the context of the 6th FP

The IST theme primarily contributed to the first pillar of the 6th FP: 'Focusing and integrating community research' - but not exclusively. It also made significant contributions to structuring of the ERA, and to a lesser but still significant extent, to strengthening the foundations of the ERA.

1.2. i2010 and eEurope

The eEurope Action Plan, adopted in 2000 as part of the "Lisbon" Implementation Strategy, was re-refocused in 2003-5[2]. In 2005, it was broadened and again re-focused as the i2010 Strategy – the European Information Society for Growth and Jobs; in which support for EU IST-RTD plays a major role.

The i2010 framework has three pillars:

– the Single Information Space

– Investment and innovation in research, and

– Quality of Life, including Flagship initiatives.

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1 http://fp6.cordis.lu/fp6/home.cfm

2 A final evaluation is underway, and a report will be available in September 2007.

i2010 Pillar 1: Single European Information Space

The first objective of i2010 is to establish a Single European Information Space offering affordable and secure high-bandwidth communications, rich and diverse content and digital services. Action in this area combines regulatory and other instruments at the Commission's disposal to create a modern, market-oriented regulatory framework for the digital economy. They include:

– review of the regulatory framework for electronic communications (including universal service and regulation on roaming);

– making the management of radio spectrum more efficient (see also Radio Frequency Identifiers (RFID), mobile TV);

– security of networks, privacy, and safety;

– creation of a consistent internal market framework that promotes the development of high quality and innovative information society and media services.

i2010 Pillar 2: Investment and innovation in research

The second priority of i2010 focuses on the EU's research and development instruments and sets priorities for cooperation with the private sector to promote innovation and technological leadership. The aim is to:

– strengthen European research in Information and Communications Technologies (ICT) through the Seventh Research Framework Programme (7th FP or FP7), the European Technology Platforms and Joint Technology Initiatives with specific proposals for Joint Technology Initiatives on nano-electronics (ENIAC[3]) and on embedded systems (ARTEMIS[4]), for decision by the Council

– make innovation and research policies more efficient; so that there is not the present disconnect between research and innovation, and so that innovation potential can be both identified and developed. (for instance, via the ICT Policy Support Programme in the forthcoming Competitiveness and Innovation Programme (CIP))

i2010 Pillar 3: Inclusion, better public services and quality of life

The third priority of i2010 is to promote, with the tools available to the Commission, an inclusive European Information Society, supported by efficient and user-friendly ICT enabled public services. The aim is to:

– ensure that the benefits of the information society can be enjoyed by everyone, including people who are disadvantaged due to limited resources or education, age, gender, ethnicity, etc. (eInclusion), and people with disabilities (e-

[3] http://www.eniac.eu/

[4] https://www.artemisia-association.org/

Accessibility) as well as those living in less favoured areas (preventing "digital divide" resulting from unequal access to high speed "broadband" connection to the Internet).

– encourage provision of better public services (e-Government, eHealth)

– harness the potential of ICT to include people's quality of life through flagship initiatives such as the Intelligent Car, European Digital Libraries, Ageing Well in the Information Society, ICT for sustainable development.

IST-RTD in the context of the i2010 framework.

In each of the 3 pillars of i2010, the IST-RTD in the 6th FP has provided ideas and a framework for collaboration with and between stakeholders. In the first pillar, intervention has included regulatory actions, such as the reform of the eCommunications regulatory framework and the Public Sector Information directive. In the second pillar, IST-RTD has provided the new knowledge on which innovations can build, including the eTEN (Now Competitiveness and Innovation Programme) and eContent*plus*. In the third pillar, IST-RTD has directly supported co-ordinated actions with Member States and stakeholders, such as the i2010 Digital Library flagship initiative.

While IST RTD in the 6th Framework Programme has contributed to all three pillars of i2010, as instanced elsewhere in this report, the major contribution is in the 2nd pillar - that of research and innovation. The Commission is addressing this pillar with four interlinked lines of action that have been established in 2005 and are still progressing, beyond the 6th FP.

The first line is about increasing public investment in ICT research and maximising its impact. During the 6th FP the Commission showed the way with a significant increase of the ICT budget for FP7. This is a step forward, but it has to be matched by similar increases in the efforts of the Member States. The strengthening of research programmes based on grants to projects is far from being sufficient, though. We need to explore all possible means to redirect parts of public spending to ICT research and innovation. This includes investments in ICT research infrastructures using resources from regional development funds. Other means include the use of public procurement to acquire innovative products and services including procurement at a pre-commercial stage. The Commission is currently working on a Communication to clarify the legal framework for such procurements, to be issued by December 2007.

The second line of actions addresses direct incentives for private investments in ICT research and innovation. In addition to general linear measures that span from tax incentives to guaranteed funds, the Commission is currently focusing on what can be done specifically for ICT. An important action that is currently under development is about facilitating the emergence of **Lead Markets** for innovative ICT products and services. The Commission, with the backing of the Competitiveness Council of Ministers, will propose at the end of this year a limited set of pilot initiatives for Lead Markets in Europe. These will include an initiative on eHealth and others where ICT will play a major role, such as energy efficiency or security.

The third line of action is about pooling of resources and better coordination of the research effort in Europe. This line explicitly supports the establishment of a true European Research Area in ICT. This is where the European Technology Platforms (ETPs) - a concept born during the 6th FP - and ultimately the Joint Technology Initiatives (JTIs) can make an impact[5].

The ultimate goal of European Technology Platforms (ETPs) is to increase the scale and the impact of private and public research and innovation investments. They help industrial and academic research communities to co-ordinate their research in specific fields and tailor it to a common "strategic research agenda" (SRA), which sets out R&D goals, time frames and action plans. The stakeholders in the technology platform agree to support the pursuance of their strategic research agenda financially, and to monitor its implementation. Technology platform represent all major stakeholders, including small and medium-sized firms, academia, and even - through their 'mirror groups' of national representatives - member states.

The existence of a Technology Platform does not imply that the Commission (or anybody else) will give the Technology Platform any special privileges, or will follow any advice offered by an ETP. Nor did the Commission "earmark" EU research budgets for ETP members or proposals. Any research projects intended to support ETP aims had to be proposed for EU research funding in just the same way as any other; they were evaluated in the same way. If selected, they were co-funded by the Commission in the same way as any other research project.[6]

In addition, in the IST domain the Commission has proposed Joint Technology Initiatives under Article 171 of the Treaty, to support ARTEMIS and ENIAC Technology Platforms, and an initiative on Ambient Assisted Living (AAL) under Article 169 of the Treaty.

The fourth line of actions is about the uptake and best use of ICT innovations by citizens and businesses. This was less evident in the 6th FP, but will become more prominent in future via a set of measures to stimulate the further diffusion of ICT across the economy and society. This includes in particular the ICT part of the forthcoming Competitiveness and Innovation Programme (CIP) that will be funding large scale pilot projects and networking activities for monitoring, assessment, and sharing of experience in ICT uptake.

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5 Detailed descriptions of the present ETPs can be found at: http://www.cordis.lu/technology-platforms

6 Only in the case of Joint Technology Initiatives, the Commission will propose to support the Strategic Research Agendas through Article 171 of the treaty.

2. PROGRAMME IMPLEMENTATION

The programme was implemented by specification of an evolving work programme together with open calls for RTD proposals to make contributions to the ambitions of the work programme. Three specific work programmes were adopted: for 2003-4 (updated midway through 2004), for 2005-6 and for 2007. Eight calls for proposals were published.

In response to the calls for proposals, a total of 7,110 proposals were received and evaluated, and 1,171 projects funded. The total funding committed amounted to 3.8M€, representing 99.8% of the allocated budget.

2.1. Use of the FP6 'new instruments' in IST

In order to be able to further focus and integrate Community research, the Commission introduced two new instruments, the 'Integrated Project' and the 'Network of Excellence'.

These new instruments and the further focusing of the content of the research activities around a shared vision of the development of technologies and their applications have been major features of the strategic approach to IST in FP6. The aim was to concentrate the research effort in areas where Community funding will have the highest impact in order to reach critical mass and to better articulate Community support with the efforts done by he Member States and the private sector.

Initially, some features of the implementation of the new instruments posed difficulties. The new instruments were poorly explained at the beginning of the 6th FP, and key documents were late. The requirements for a detailed 12/18 month workplan, over-complex proposals, and audit certificates were sources of administrative burden. These difficulties were recognised and acted on during the course of FP6, leading to better guidance being produced in 2004, and other simplifications to administration (within the constraints of rules and regulations).

2.2. The Work Programme

The IST in FP6 Work Programmes defined the priorities for the calls for proposals, the instruments to be used in each domain, the implementation plan and the criteria that were to be used for evaluating proposals responding to these calls. These were all derived from an intense consultation process, including SWOT analyses, that explored Europe's options at the economic, social and technology levels.

In comparison with FP5 and previous FPs, the FP6 WPs were characterised by two main strategic components: **focus** and **concentration of effort**.

2.2.1. A focus on a European vision for ICT development

In order to ensure leadership and greater benefits for industry and citizens, IST in FP6 has been focused on a vision for the development of Information and Communication Technologies (ICT) that builds on Europe's strengths, that opens

the door for a wide range of new business opportunities and that makes the technology and its applications accessible, in an easy way, to all citizens, everywhere and at any time. This vision was developed by the European ICT industrial and academic stakeholders in research and development and in particular the IST Advisory Group.

The rationale for the vision, in addition to its wide societal and business impact, is that Europe's main technology and industrial strengths are in telecommunication equipment and services (especially mobile and wireless), in embedded ICT systems and in several specific markets of microelectronics and integrated micro-systems. Europe is also present in business software, in home systems and in applied ICT fields especially health and transport. Europe's industry is not present in computing, in packaged software and general internet technologies although Europe has very good academic research in these fields.

2.2.2. Concentration of effort by means of use of FP6 instruments and a shift in the approach to the Work Programme.

The arrangements in FP6 and their rationale are best understood by comparison with the arrangements in FP5. In FP5, the Call priorities in the IST Work Programme were described through what were called "Action Lines". For a budget of around 850 M€ per year, an IST Work Programme in FP5 included up to 90 different Action Lines. As a result, IST in FP5 supported almost 3000 projects with an average funding of just 1.8 M€. Fewer than 10 projects had budgets greater than 7M€, representing together less than 3 % of the total budget.

Industry, the research Community and the various evaluation and monitoring exercises all highlighted the need to support larger integrated research efforts (in appropriate situations).

The availability of the new instruments introduced in FP6, and in particular the Integrated Projects, was a step forward, but in order to be able to finance Integrated Projects of sufficient size together with more focused and targeted research projects, the style of the Work Programme was changed to focus on a limited set of Objectives, and in each call for proposals the anticipated balance of instruments was indicated. The yearly budget in FP6 supported 12 Objectives, in contrast with the 90 Action Lines of FP5.

3. STRATEGIC IMPACT

During the time of an execution of any Community Framework programme (and approximately half of the FP6 projects are still ongoing) it is impossible to discern with any statistical validity the impact of finished projects. To enable the Commission to adapt and update its priorities and the work-programme, the formal analysis of impact is therefore based on projects from previous Framework Programmes. During FP6 the Commission has launched a series of pilot analyses of the impact of projects from FP4 and FP5.

These have been followed by the deployment of an 'impact analysis observatory' that is currently in the final stages of the analysis of the impact of FP5 projects. The observatory is conducted by a consortium of external organisations with long standing expertise in impact analysis. It will start addressing finished FP6 projects from the beginning of 2008.

Nevertheless, the 6th FP has been running since 2003, so there are indicators of specific impacts of particular activities, and some of these are reported here.

3.1. Creating and sustaining world leadership

In some fields, despite intense global competition, Europe has world leadership. In telecommunications and audiovisual systems, the 6th FP has contributed to reinforcing leadership, whilst opening opportunities for new entrants, notably SMEs. Not only do leading companies continue to participate in the EU FP, but the technology performance achievements are still ahead of comparable developments elsewhere. Radio-spectrum efficiencies, for instance (in bit/sec per Hz) are ten-times ahead of current systems and commensurate with Japanese and Korean achievements.

RTD in FP6 has demonstrated world record miniaturisation results with 45 nm CMOS technology. Europe also continues to be at the leading edge of Extreme Ultra Violet lithography development for the subsequent 32nm and 22nm technologies. Two European companies are in the top 10 list of Integrated Circuit manufacturers. Five European SMEs and Europe's big 2 are in the top 10 list for wafer processing.

The new Electronics on Plastic by Laser Release process has been validated in a commercial manufacturing environment. This has allowed the production of an extremely thin defect free e-paper flexible display to be demonstrated. This is currently the *only* technology for flexible active matrix backplanes compatible with standard display manufacturing, and is therefore well-placed for industrialization.

In the area of high speed research networking and GRIDs, GÉANT2 is the global leading infrastructure, both in terms of geographic coverage and in terms of technical capabilities. It now enables advanced collaboration for well beyond 60 million researchers and users around the world. By delivering a combination of high bandwidth, unrivalled geographic coverage and user-focused services GÉANT2 is pushing forward multi-national collaborative research in areas such

as climate change, life sciences, radio astronomy, sustainable development, and grid computing itself.

The European Quantum Information and Processing community is at the international forefront of a very competitive, rapidly growing field at the cutting edge of science acknowledged by numerous prestigious prizes awarded to members of the community, among them the 2005 Nobel Prize in Physics to Theodor Haensch. Yet another Nobel Prize in Physics was awarded in 2007 to Albert Fert, for his work on Spintronics, associated with nanoelectronic IST research in the 6th FP.

EU support to RTD on broadband access has continued to be of major strategic impact. European researchers and companies continue to lead in world developments of mobile "4G" systems, and in setting global standards for 4G, and "power line" communications, ultra-wideband radio (UWB), and satellite broadcasting.

The work on content and knowledge technologies is reinforcing European leadership, and particularly the ongoing work in *digital preservation* places EU at the forefront of research, notably when compared with the work carried under the US initiative NDIIPP[7].

EU Support for RTD on *artificial cognitive systems*, bringing together previously fragmented topics of research on software design in the face of uncertainty and need for adaptation, and cognitive systems engineering drawing on disparate disciplines from engineering to the bio-sciences, has formed and nurtured a research community to the extent that cognitive systems is now a recognised discipline in its own right - a discipline with European leadership, in which the US NSF, among others, is now following.

The area of Biomedical Informatics was launched for the first time during the 6th FP. It brings the advances of genomics research to healthcare by facilitating synergy between the previously separate disciplines of bioinformatics, medical informatics and neuro-informatics. The EU-level focus for this work has established Europe as a world leader in this area.[8]

3.2. Strengthening collaboration in the European research area and beyond

IST-RTD projects have brought together over 4500 industrial and academic partners - users (such as network operators), suppliers (such as manufacturers), and providers of new ideas (such as academia) - in an effective mechanism for generating new ideas from research and transferring them into practice.

The clustering of projects and the establishment of European Technology Platforms has extended cooperation beyond the collaboration that can be achieved in individual projects, and it has fostered wider pre-competitive

7 National Digital Information Infrastructure and Preservation Program - http://www.digitalpreservation.gov/

8 See, for instance, www.europhysiome.org

contributions to direction-setting and dissemination, with synergies that would not be obtained through participation in the Framework Programme alone.

In the area of Future and Emerging Technologies, several Proactive Initiatives have contributed to the development of the ERA by structuring and further strengthening the research capacities and the related communities in the areas of quantum information processing and communication, nano-electronics, robotics and complex systems research, thus significantly contributing to make Europe a world leading force in these areas. To take quantum information processing and communication as an example, a European research community has been forged, with 150 groups and 1800 researchers spread over more than 30 countries, with excellent results such as quantum teleportation in free-space over a distance of 144km.

The new instruments in the 6th FP - Integrated Projects and Networks of Excellence - contributed to achievement of more intense[9] and more complete[10] collaboration than in previous Framework Programmes. Although not an explicit requirement, the new instruments have quite naturally brought together all the key RTD players in key areas. At least one of the top 3 national RTD "hubs" participated in the IST-RTD network for eleven EU15 Members[11], and for 2 new Member States (Poland and Slovenia). The most important national research centres in Member States participated in the EU IST-RTD network[12]. Comparative analysis with other EU and national programmes also shows that participation in EU IST-RTD projects was most effective in linking universities and businesses; connecting research in different themes and disciplines; and in integrating New Member States, patent holders and SMEs.

Collaboration has been extended beyond that achieved simply through participation in IST-RTD projects by:

– forging stronger links to the major EUREKA clusters (CELTIC and MEDEA);

– facilitating linkages at the national level[13];

– supporting other collaboration fora such as the eSafety Forum, the European Grid Initiative and the EGEE Industry Forum, the European "Complex Systems Society", the "Living Labs" network, and various standardisation frameworks and business associations;

– stimulating participation in European Technology Platforms.

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9 The average distance (number of links) between RTD organisations was about 3.14 to 3.16 from 1992 to 2002 in the 3rd, 4th and 5th Framework programmes, but was reduced to 2.63 in the 6th Framework programme.

10 Almost all (98%) participants in IST research are included in a single connected network.

11 with the exception of Austria, Denmark, Luxemburg, and Ireland.

12 With the exceptions of the United Kingdom, Ireland, Cyprus and Estonia.

13 The French TVMSL project is a direct spin-off of EU RTD: www.tvmsl.com.

The IST-RTD has been the stimulus and foundation for the formation of nine European Technology Platforms; each of which has agreed a Strategic Research Agenda. Over 650 companies participate in the ETPs on eMobility; Networked Electronic Media (NEM); Nano-electronics (ENIAC); Networked software and services (NESSI), Embedded systems (ARTEMIS); Photonics (CEPRI); Smart system integration (EPoSS); the European Robotics Platform (EUROP) and satellite communications (ISI - the Integral Satcom Initiative).

Two of the IST technology platforms, ARTEMIS - on embedded systems - and ENIAC - on nano-electronics, have advanced to the stage that they have proposed to establish Joint Technology Initiatives.

The European Technology Platforms have also led to greater collaboration and co-ordination with national programmes through their 'Mirror Groups' of national representatives, and through the national 'mirror platforms' stimulated by the ETPs[14].

IST-RTD has also directly contributed to increased cohesion between European and national programmes. ERA-Nets[15], or 'IST Co-ordination Projects', have brought together national RTD funding agencies to explore the potential for harmonisation and even integration of national programmes and EU programmes. In the domain of Micro- and Nano-technologies and Microsystems, for example, the funding agencies of a number of Member States have worked together to identify common and compatible interests within this domain, and then to harmonise their processes so that they have been able to make a fully co-ordinated pilot trans-national call for proposals in 2006. From an initial consortium with representation of just 8 countries, this initiative, 'MNT ERA-Net', has now attracted the participation of 18 countries, encompassing 24 national programmes[16].

In **Grid technologies**, a Co-ordination Action has strengthened both co-ordination among funding authorities and collaboration among researchers in national and EU Grid research programmes. A Network of Excellence, by acting as a single European Research Laboratory, has contributed to the harmonisation of the Grid scientific roadmaps of the participating organisations.

Building on RTD, collaboration has been stimulated beyond the research community: For example, the RTD on **wearable health-monitoring** led to the creation of a working group in the IEEE standardisation framework on wearable systems, and to an alliance grouping more than 100 companies[17]. Through IST biomedical informatics research, Europe is recognised as world-leader and a

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[14] E.g. PROMETEO (www.prometeo-office.org) and SIMETRA - the Spanish and Finnish 'mirrors' of Artemis

[15] See www.cistrana.org/projects/98.htm for an overview of ERA-Nets in IST

[16] MNT ERA-Net: www.mnt-era.net

[17] The Continua Alliance : www.continuaalliance.org

working group has been established by the International Medical Informatics Association to co-ordinate worldwide interest[18].

3.3. Strengthening links to SMEs and regional innovation

Particular attention has been given to participation of small businesses (SMEs) in the calls and in the eventual funded work programmes. Those participating in IST-RTD are significantly more technologically active (i.e. they patent more) than most SMEs: around 25% of SMEs involved in the IST-RTD projects have at least one patent vs. 5% of most SMEs. National Contact Points in Member States also confirm that participating SMEs are more innovative than others.

The level of participation of SMEs has also been sustained at over 20% of participations, and 16% of budget allocations. This is significantly greater than the 15% target set by the Council and parliament for the 6th FP as a whole. However, only a small fraction (5.4 percent) of European SMEs holding highly cited ICT patents have participated in IST-RTD projects, and only a small fraction (3.3 percent) of the most dynamic European SMEs[19] have participated in IST-RTD projects. For most innovative SMEs, growth perspectives are crucially linked to a short time-to-market introduction of new products and services and management of intellectual property rights, and participation in collaborations with larger organisations in multi-annual research may be often not in their best interests.

Support to RTD in some areas has opened up opportunities for SMEs at the local and regional level. RTD on the networked enterprise has provided new tools which are exploited in the REDEN network[20], and in "enterprise interoperability centres"[21]. Participation has allowed a number of SMEs[22] to position themselves as credible vendors of advanced content/knowledge management solutions, and to create their own customer base.

Software and service capabilities reinforce Europe's strengths in many other industrial sectors, such as telecoms, automotive, aerospace, consumer electronics and engineering. Software-oriented research in the 6th FP, and in particular, significant support to open software and services and to service-oriented (software) architectures, has made it easier to develop flexible, interoperable systems and hence, more complex, dynamic and diverse value chains. This in turn has a catalytic effect on competition, by opening opportunities for new players, particularly innovative SMEs, in the software domain (which is today heavily dominated by a number of global players). Taking this a step further,

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18 Publication in bio-informatics : www.symbiomatics.org

19 Companies achieving the highest rates of growth during the period 2001-2004 in the relevant technological domains, from the Top500 fastest-growing European companies as reported by Business Week (October 24, 2005).

20 REgions for Digital Ecosystems Network (http://reden.opaals.org).

21 www.eic-community.org

22 Ontoprise, iSoco, Empolis, Exalead, Sirma, Expert System …etc

Digital Business Ecosystems research has enabled the creation of co-operative service platforms that can be opportunistically reconfigured to match the time varying business requirements of networked SME's. This research has already yielded significant results, with regional deployment already taking place or planned (notably in Italy).

RTD on "cognitive systems" is highly multi-disciplinary, but a number of high-tech SMEs[23] are involved in the design and construction of robots, offering specific advanced technologies,

3.4. A strong foundation for i2010 policy initiatives

The IST-RTD in the 6th FP has been the source of ideas and mobilisation for an increased number of policy initiatives in the i2010 framework. 34 policy initiatives have been taken by the European Commission during 2004-7 on the basis of developments in the 6th FP. This reflects a recommendation in the 5-year assessment of IST-RTD in 2004 for a stronger policy mix: an optimum combination of RTD, innovation support, awareness-raising and policy interventions.

Indeed, although research activities are fundamental to achieving the overall objective of - for instance - making content accessible to all, they may not be sufficient by themselves to spur innovation and competitiveness; to translate knowledge into new products and services; and to support the emergence of markets with high economic and societal value. The equation relating policy, research, innovation, and competitiveness is complex.

To implement such a mix of policies requires interconnected and focused actions, spanning research and technological developments, innovation related activities, monitoring and awareness raising, and regulatory actions. Research activities have therefore been framed in a more comprehensive strategy which coherently tackles innovation, awareness-raising, and regulatory actions - where and when they are appropriate and as necessary.

While specific IST-RTD actions have sometimes contributed to more than one of the i2010 pillars, the following descriptions of such contributions is structured according to where the main emphasis of an action lay.

3.4.1. i2010 Pillar 1: Single European Information Space

Policy and regulatory issues affecting digital content - in particular intellectual property rights, copyrights, database protection, and Digital Rights Management - have been addressed alongside the research-based evolution of content creation and management technology. Indeed, the Commission unit responsible for this topic now supervises the implementation of the Community strategy on public sector information as well as the Digital Libraries initiative, and acts as contact point for the whole of DG INFSO on intellectual property matters. This same

23 Telerobot Srl, Bluebotics SA, Cambridge Research Ltd, Altjira SA, Radon Labs GmbH, Analogic Computers Ltd, K-Team, Noze srl, Otto Bock GmbH etc

unit supports the fight against illegal, harmful and simply unwanted content on the Internet (with a special emphasis on the protection of minors) through mutual awareness of the 'Safer Internet Plus' Programme (2005 – 2008).

Under the 1st pillar of i2010, IST-RTD has also supported the development of the 'Single European Electronic Market'. Research into broadband networks has paved the way to further capacity increase – at lower cost - of end-to-end networks, which in turn promises the enablement of novel bandwidth hungry applications - advanced tele-medicine, for instance. The wireless part of this work has been also largely recognised as an international benchmark of the state of the art in this field. This work has enabled EU participants to play a very significant role in the formulation of global standards in a number of domains, such as Power Line Communication, Ultra-Wide Band, 4G mobile, and satellite broadcast. This enhances the prospects for downstream commercial exploitation by EU industrial players. This work has also had significant impact on the related spectrum regulation that was developed in Europe in these fields.

RTD on **networked audiovisual systems** has contributed to increased availability of on-line content whilst preserving users' and right holders' interests. As an example of the interaction between the various pillars of i2010, this work primarily under pillar 1 has also had a major influence on quality of life (pillar 3), particularly in the context of **extended home environments**, as it enables novel approaches to education, health and culture, in addition to providing major opportunities for wealth and job creation. This work has helped to accelerate convergence of IT, telecommunications and consumer electronics. It has notably provided a strong foundation for i2010 policy initiatives on **mobile television**, with a preference for the DVB-H standard, and for launch of satellite broadcasting to mobiles on the DVB-SH standard by European manufacturers and operators.

A key element in the forthcoming Commission proposal for reform of the eCommunications regulatory package under the first pillar of the i2010 framework is the Wireless Access Policy for Electronic Communications Services (WAPECS) principle. This calls for a more efficient use of the radio spectrum, a scarce and valuable resource that governments want more and more to value at its true price. WAPECS aims for a 'technology and service neutral' usage of frequencies. Whilst this principle is conceptually very attractive, it raises significant implementation problems. RTD in the 6th FP in the field of cognitive radio is paving the way towards a practical implementation of the principle and has already proved so successful that the participants in the research are currently moving towards standardisation, as exploitation prospects emerge.

Work on interoperability, another first pillar topic, has been pursued via IST-RTD in the fields of both software and the networked enterprise. Software developments, and particularly the emergent 'service-oriented architectures', now enable interoperability across a multiplicity of content and network platforms, with service elements provided by a multiplicity of vendors. In

addition, the **"Enterprise Interoperability Centre"** was launched in April 2006 in Brussels[24]. This is a 'Virtual Laboratory', which coordinates a network of regional poles from twelve European countries and from China and synergises 500 researchers. It provides a platform for companies to discuss interoperability issues in their business relationships, with focus of business to business processes.

3.4.2. i2010 Pillar 2: Investment and innovation in research

Under the second pillar of i2010, a European Network of **Living Labs** has been established, launched by the Finnish EU presidency in November 2006. This comprises 5 Integrated Projects, initially, together with 2 Coordination Actions. It is an example of the combination of research, development and innovation in order to facilitate the interplay between different stakeholders such as users, buyers, entrepreneurs, scientists, engineers and policy makers.

3.4.3. i2010 Pillar 3: Inclusion, better public services and quality of life

The research behind the **eGovernment** action plan[25] contributed to the ministerial declaration in Riga[26] and to the wider appreciation of the value of ICT-based transformation of government services in the Lisbon strategy. Research in the 6th FP has contributed to the definition of priorities and to the identification of legislative or infrastructural gaps for the implementation of the 3rd pillar policies. It has also provided important contributions to continuing policy and competitiveness initiatives on electronic identities, electronic and pre-commercial procurement, and wider participation in democratic processes.

The Action Plans on e**Accessibility**[27] and on **eInclusion**[28] build on and strengthen the research that has been performed in the 6th FP into applications of ICT-based innovations that have special applicability in these domains, such as automatic surveillance to support web accessibility, and 'Design for All'. The concept of design-for-all is now incorporated into the revised EU Public Procurement Directives and supported by an EC mandate to the European Standardisation Organisations. FP6 research into networked audio-visual systems underpins the ambitions for care in the community which will be feasible and practical with home systems providing a caring and secure environment, nurturing the ageing and less agile in their own homes and trusted environments.

In turn, the Riga ministerial declaration on eInclusion[29] calls for further research into e-Accessibility and ICT for Ageing, and a co-decision proposal for a new applied research co-operation of member states[30].

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24 www.eic-community.org

25 http://ec.europa.eu/information_society/activities/egovernment/policy/action_plan/index_en.htm

26 http://ec.europa.eu/information_society/events/ict_riga_2006/doc/declaration_riga.pdf

27 http://ec.europa.eu/information_society/activities/einclusion/policy/accessibility/index_en.htm

28 http://ec.europa.eu/information_society/activities/einclusion/index_en.htm

29 http://ec.europa.eu/information_society/events/ict_riga_2006/doc/declaration_riga.pdf

RTD on digital content has been co-managed with the eContent programme; the Safer Internet Programme and with policy development and awareness-raising for public sector information[31] and digitisation of cultural material, notably the Digital Libraries initiative[32]. The Digital Library flagship initiative is an example of how RTD and a strategic political initiative can mutually reinforce each other. (And of the benefit from consideration of all 3 pillars of i2010 at the same time.) It provides structured collaboration between cultural heritage institutions and providers of technology-based services and gives high visibility to digital libraries research, particularly through the launch of the European Digital Library. Development of technologies for "digital preservation" must be coupled with regulatory developments (mandatory deposit and archival of digital information) to create new markets for digital preservation and archival services.

Work carried out in the field of networked **Radio Frequency Identifier** systems is also at the heart of industry competitiveness. By developing solutions making networked RFID systems more pervasive in enterprise systems, business efficiency is expected to significantly increase - by as much as 30% according to a report of the Danish Presidency in 2007. The coherent and co-ordinated exploitation of **Radio Frequency Identifiers** (RFIDs) in European business has been an area of positive synergy between RTD and i2010 policy initiatives and. RFID-related research has already led to harmonisation of UHF spectrum use. This research has been led as part of a comprehensive policy initiative aiming at guaranteeing consumer rights when such pervasive technology is massively adopted. A public consultation has recently been initiated to seek the opinions of a representative public.[33]

Research Infrastructure activities significantly contributed to realisation of the 3rd pillar of i2010 by further developing and deploying enhanced communication facilities to all researchers across Europe. Existing services were extended to cover schools in the Member States (e.g., Greece, Italy, Portugal) and to provide support to the eHealth community (e.g. in Nordic region). eGovernment activities were also supported by national research and education networks (e.g. UKERNA and BELNET).

New collaborative working technologies developed within FP6 will underpin innovative Ambient Intelligence applications and the emergence of the future knowledge society. In particular, and also under the 3rd i2010 pillar, new collaborative working technologies for eWork will underpin efforts to reduce the digital divide and support eInclusion. In combination with the open source architecture and tools developed within the area of software technologies and the

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30 COM(2007) 329

31 Re-use of public sector information : Directive 2003/98/EC and Decision 2006/291/EC

32 Digital Libraries - COM(2005) 465; Commission Recommendation on the digitisation and online accessibility of cultural material and digital preservation (2006/585/EC); Council Conclusions on the Digitisation and Online Accessibility of Cultural Material, and Digital Preservation (2006/C 297/01), and Communication from the Commission on scientific information in the digital age: access, dissemination and preservation. COM(2007) 56

33 Radio Frequency Identification in Europe: COM(2007)96, 15.03.2007.

"Technologies for Digital Ecosystems" cluster[34], these technologies contribute to fostering local economic growth and stimulating innovation in rural areas. They help to preserve local knowledge, culture and identity and boost local development, co-operation and knowledge-sharing among European SMEs, enabling these to overcome the digital divide. Joint uptake of FP6 Digital Ecosystems research results is now actively being planned by the REDEN network, which includes already 25 regional catalysts.

The 6th FP projects focused on road and air-safety provided a foundation of RTD and collaboration support to over 250 organisations[35] and for the **"Intelligent Car"** initiative under the 3rd pillar of i2010. This has been the subject of two policy communications to the Council and Parliament[36]. The RTD projects have also been instrumental in setting up two major public events[37], which attracted wide media attention.

3.5. An increasingly valuable basis for other policy initiatives

IST Research in eGovernment in the 6th FP has informed revision of the eEurope 2005 Action Plan and underpinned development of the 'Single European Electronic Market' initiative. It has provided a valuable basis for policy initiatives by other Commission services, such as DG MARKT and DG TAXUD, concerned with **company registration** and **customs procedures**.

The RTD in the area of environmental monitoring and disaster management has enhanced the interoperability between geo-spatial information systems, improved collection and integration of harmonised environmental data and access to that data, and strengthened monitoring capacities. Developments include decision support, **early warning and response** systems, and **sensor networks for disaster management** as an aid to sound disaster and emergency management. These have all contributed to implementation of the Sustainable Development Strategy and strengthened European capacities for **Global Monitoring of the environment and security (GMES)** and the **Global Earth System of Systems (GEOSS)**.

Projects have also contributed to development of **Civil protection interoperability**[38] and the creation of a **Public Safety Communications Forum**[39] to harmonise communications in first response and rescue.

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34 www.digital-ecosystems.org

35 www.esafetysupport.org, including the list of members.

36 http://europa.eu.int/eur-lex/lex/LexUriServ/LexUriServ.do?uri=CELEX:52003DC0542:EN:NOT , http://europa.eu.int/eur-lex/lex/LexUriServ/LexUriServ.do?uri=CELEX:52005DC0431:EN:NOT

37 http://www.esafetysupport.org/en/esafety_activities/esafety_forum/plenary_meetings/7th_esafety_forum_plenary_meeting_28_february_-_1_march_2007.htm http://www.prevent-ip.org/en/news_events/public_events/ip_prevent_exhibition.htm

38 http://ec.europa.eu/environment/civil/prote/cp02_en.htm

39 http://www.publicsafetycommunication.eu/

Several FP6 projects and studies have contributed to development of European policy in eHealth, especially in regard to patient summaries (electronic health records). The work in FP6 has fulfilled the EU objectives of creating an eHealth ERA that covers numerous areas of eHealth research, support to enlargement, implementation of research and development activities in Member States, standardisation of activities and sustainability of the economy[40].

Results from research that connects cutting-edge ICT to European environmental policies has supported the implementation of specific EC Directives such as the Water Framework Directive and the recent INSPIRE Directive.

IST Research in the 6th FP has underpinned the developing concept of public procurement in R&D, also known as **pre-commercial public procurement**[41] (PCP) as a means to improve Europe's capability to turn its research achievements into concrete innovation opportunities. PCP has a huge potential to stimulate the demand for new technologies and to bridge the needs for innovation of public organizations as "first buyers" of products generated through procured R&D. Pre-commercial public procurement would stimulate industrial interest in R&D for public sector domains in which industry would otherwise not invest, with particular advantages for those rapidly changing high-tech sectors (especially ICT) where time-to-market is critical and where the "first movers" usually get competitive advantages. These developments have entailed inter-service work with DGs RTD, COMP and MARKT.

The IST-RTD on **quantum communications** that has resulted in the demonstration of a secure bank transfer has been taken up in the security objective of the IST programme.

Albeit more speculatively, IST-RTD is investigating how scientific developments, particular complex systems research, could help in the design of policies that are economically, ecologically and ethically viable and how new methods of scientific analysis could form a framework for informed decisions on inherently complex matters such as sustainable development, public health, deployment of new technologies, innovation, national security, and mitigation of natural disasters.

In other areas, the research is ahead of what can already be reflected in regulatory initiatives, and many of the technology developments supported in the 6th FP will provide a new foundation for policy initiatives in 2009-2011 provided that the synergy between RTD and policy can be sustained.

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40 *"eHealth priorities and strategies in European countries"* (http://ec.europa.eu/information_society/activities/health/docs/policy/200703ehealthera-countries.pdf)

41 http://ec.europa.eu/information_society/research/priv_invest/pcp/index_en.htm, http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm

3.6. Strengthened International co-operation

The IST-RTD in the 6th FP has been effective in attracting more than half of the top 25 global leaders of innovation, themselves hubs of the global innovation networks in this area. These global research and innovation "hubs", whether headquartered in Europe or elsewhere, are also "hubs" in the European research networks, and provide a strong connectivity between the European IST-RTD community and the global innovation processes. Participation in Integrated Projects in particular is very effective at connecting European ICT research participants to the rest of the world. The evaluations in 2004 and 2005 showed that the European RTD community is an integral part of the broader global RTD and innovation community in the IST area: It is able to feed into, and draw from the wider knowledge creation community in the US and Asia.

International co-operation between the EU and China, India and Africa, has been strengthened: the number of participations nearly doubled since the 5th FP; the funding to 3rd country organisations was six-times higher[42]; and the number of collaborative links has increased ten-fold. Major collaboration events were supported: in China, India, and Africa. The participation of 3rd countries organisations has been especially important in RTD on networking and media processing, where collaboration is at global level through the Digital Living Network Alliance, or in Asia (IGRS in China, UOPF in Japan, HNF in Korea).

GÉANT2 has direct connections to research networks in the US (Internet2 and ESnet), Asia-Pacific (TEIN2), China (ORIENT), Central Asia and Caucasus (SILK/OCCASION), India, Japan (SINET), Latin America (ALICE-RedCLARA) and North Africa/Middle East (EUMEDconnect). The latest GÉANT2 extensions demonstrate that the approach pioneered with GÉANT in Europe can form the template for a worldwide research community. EGEE, the European flagship Grid infrastructure, has been the platform for numerous international collaborations, and international cooperation in this area has been particularly successful with China and Korea, where European Grid research and business communities have established numerous links with academic partners to share experiences in Grid technologies and applications, identifying new potential markets for European products and services.

Research into 4G mobile systems, extended home networks, Grids, and Mobile TV has stimulated international co-operation, with a view to reaching global standards. In these fields, the main industrial players have established partnership with Asian nations (mainly China, Korea, and Japan). This is an example where the research is not necessarily overtly international, but can support an international ecosystem in which European industry is an important component. In addition, co-operation with Latin America has also led to the adoption of European DVB technology in some Latin American countries.

[42] 41 million € vs. 7 million M€ in FP5.

International inter-agency collaborations with targeted countries - particularly US, India, China and Russia - have been established in the area of Future and Emerging Technologies.

International co-operation with developed countries continued in the framework of the **Intelligent Manufacturing Systems initiative.**[43] The vision underlying this long-term (more than 10 years) initiative is for a global system of industrial cooperation and technology sharing in cooperative projects for the benefit of mankind in general and for the benefit of partners in particular. IMS provides a framework for large and small companies and research organisations worldwide to work together to mutual advantage. Five regions, including the European Union, Japan, Korea, Switzerland, and the United States of America, are at present engaged. Research supported in the 6th FP[44] has enabled participants not only to participate in the Intelligent Manufacturing Systems initiative, but to benchmark European achievements with the strongest competitors worldwide. In 2005 almost half the 1000 participants were from the EU and Norway, and more than half the IMS projects leaders were based in the EU.

However, partly as a consequence of the lack of a 'ringfenced' budget for IMS in the 6th FP, only two new IMS projects were launched under the two joint calls between IST and NMP in FP6 - both of them with IST. Around this time, IMS completed its first 10-year phase (on 30 April 2005). But while Japan, South Korea, Switzerland and the USA soon signed up for a follow-on phase, the European Union took until 22 March 2007 to decide to continue EU involvement in IMS.

IST-RTD into Future and Emerging Technologies has contributed to the **Human Frontier Science Programme**, an intergovernmental programme to promote fundamental research in higher brain functions and molecular approaches to biology with emphasis on inter-disciplinarity and intercontinental collaboration.

The work in the 6th FP on eHealth has sparked international interest, with requests for cooperation from China, US and others.

However, unexpected developments (though not scientific or technological developments) have affected International Cooperation activities in the domain of Networked Audio-visual. In this domain, International Cooperation was focused on two target regions: 1) Latin American countries, with an emphasis on Brazil and both digital terrestrial broadcasting and mobile interactive broadcasting and 2) China with emphasis on Digital Terrestrial Broadcasting and Home Networking. Soon after the evaluation of the 6th call for proposals of the IST program the Brazilian government issued a Presidential decree (No. 5.820) concerning the adoption of the Japanese based ISBTVD-T standard and the Standardization Administration of China announced that the national DTT standard will be the combination of three systems (ADTB-T, DMB-T and TIMI) all developed by Chinese research organisations. These decisions had an impact

[43] http://www.ims.org/

[44] http://www.manufuture.org/

on the consortia of the selected for funding proposals of Call 6, as well as on their middle-term research and exploitation plans.

4. EFFICIENCY AND SIMPLIFICATION

The provisions for the IST thematic priority, as decided by the Council and Parliament, have been fully implemented on schedule. Eight calls for proposals were published. A total of 7,110 proposals were received and evaluated, and 1,171 projects were funded. Over 99% of the commitment and payment credits were used each year, and over 80% of payments were completed within the target time. This was facilitated by increasingly efficient IT tools, including electronic submission of RTD proposals. From the 3rd Call, all proposals were submitted electronically. This reduced the burden (of numerous copies) on proposers, enabled them to more easily format their proposals as required and to incrementally improve them without penalty, enabled automated verification of essential properties of proposals, and speeded up the preparation of the evaluations of proposals.

The evaluation of proposals has become more efficient and robust. The evaluations were completed on schedule. They were monitored by external experts, whose recommendations were followed up after each evaluation. Best practices were taken up across the full spectrum of themes through targeted training for Commission Officials and improved briefing for evaluators. There was one exception to the otherwise excellent track record for evaluation: during the evaluation for one call, a significant inefficiency arose when, because of a potential conflict of interest that could have affected the outcome of a proposal evaluation but was reported too late for corrective action, that part of the call had to be repeated - at considerable inconvenience and expense. The evaluation and monitoring processes were modified to avoid this problem in later calls of the 6th FP, and in future.

Strong competition for EU funding (in most calls and areas, the available budget was oversubscribed about 6-fold and in some areas more than 10-fold) has **ensured a very high scientific quality in the funded proposals**. There is, nevertheless, a corollary, that the nugatory effort devoted to preparation of so many unsuccessful proposals may be considered a burden on the community.

However, proposal-level selection has made it difficult to assemble a complementary portfolio of projects in areas where it is desired to gain benefit from synergies and to prevent unnecessary overlapping of research efforts. Considerable management attention has therefore been given to concertation and clustering of selected projects to create a coherent and focused set of activities. However, greater flexibility at the level of budget allocations and a stronger approach towards considering clustering of projects in particular domains, could potentially bring about such a coherent and focussed set of activities in a more efficient manner.

A reorganisation of the evaluation combining remote evaluation, ability to verify proposal's claims, streamlined structure of proposals could improve the quality of proposals and optimise the use of evaluators' time, making it easier to attract the best. Note that evaluation in the FET Open scheme is already performed in two steps, with short proposals evaluated remotely followed by full proposals evaluated with the standard procedure. This has proven very effective for the constituency, giving a deadline-free mechanism for screening initial ideas without burdening consortia in writing full proposals, although it required significant extra efforts from the Commission services to manage a double evaluation process.

The efficiency of the negotiation and signature of the grant agreements has been improved. However, the "time to contract" for proposal submission was initially longer than the average for the 5th FP (238 days) for FP6. This was due to the unfamiliarity of the "new instruments (IPs and NoEs), which were also larger and more complex, and the addition of a "hearing" with the proposers of these measures at the short-listing stage of the evaluation and selection procedures. It was also initially necessary to draw budget from two financial years to fully engage selected projects from the first Call(s). The average "time to contract" over the 6th FP was 293 days, but this was reduced to 230 days for the last Calls - comparable with FP5.

Project management became more efficient in DG-INFSO during the 6th FP, with the change from paper-based work-flows to fully electronic systems. Efficiency also improved with integration of the IT systems for contract generation and management, and with payment management. Annual project reviews have monitored the quality of work and few projects under-perform: most projects have delivered good scientific and technological work (especially NoEs and IPs).

During the period 2002-2006, the organisational arrangements of the Luxembourg-based Directorate responsible for "Digital Content and Cognitive Systems" were streamlined. A new ICT-research unit was created, and the teams working on content and knowledge technologies were merged, as were the teams working on cultural heritage and technology-enhanced learning. Robotics research activities, previously spread in various Directorates were concentrated in the one Directorate. These changes all gave rise to efficiency gains in terms of eased daily activity management and reduced needs for coordination - an issue particularly important given the physical dislocation of the Directorate from the remainder of the Directorate General.

The legal framework and the new "grant agreements" have been found to be satisfactory. The rules for participation and the model contracts are better than for the 5th FP. However, they presented some difficulties for the "open source" community. Some tensions were also observed between research organisations relying on the open source model for dissemination and exchange, and industrial actors strongly relying on proprietary models.

The complexities of participation are still a barrier to first-time SME participants. The provision for joint financial liability was initially counterproductive for SMEs, with some organisations reluctant to take risks with weaker partners. Some participants have also reported difficulties with the more restrictive conditions on sub-contracting.

The rights of subsidiaries to the knowledge gained within a project and the potential transfer of that knowledge to parent companies (in particular outside the EU) raised concerns.

Given the limited scope of the Grant Agreement with the Commission, it needs to be complemented with a consortium agreement. Experience has shown that well-balanced and industry-led projects generally have good agreements, but it remains important to motivate proposers to reach such agreements before signing the EC Grant Agreement.

There also remain concerns that the grant agreement does not provide sufficient insight on the real effort made by the participants, nor sufficient information on the real costs incurred, which remains the basis for EU funding.

To increase the reliability of such "cost claims", a requirement of **"Audit certificates"** was introduced for all participants and all payment periods. These were found to be of limited value and quality, and were a disproportionate administrative burden. To reduce this burden, the requirement was waived for smaller organisations during the latter part of the 6th FP.

4.1. Improved understanding and effectiveness of the new instruments

The new instruments presented a non-negligible challenge, both in the Commission and to stakeholders. Due to their novelty, an adaptation period was needed both by the EC services and by the R&D constituency to arrive to an optimal implementation of the research activities by means of the new instruments. The understanding of the instruments and new implementation modalities were improved through better guidance documents, through internal and external information initiatives, through changes to the procedures, where possible; and through increasing appreciation by the community of the expectations of the new instruments and of the opportunities they present.

A mismatch between initial expectations for **Integrated Projects (IPs)** (in terms of size, budget, scope and duration) and the possibilities of budget appropriation resulted on the partial (phased) implementation of some of the larger IPs. This was initially of some concern. However, where there is a large presence of major industrial forces (manufacturers, operators and service providers), the industrial drive and momentum can not anyway be ensured for time horizons exceeding typically 2 years. The size of proposed IPs is now consistent with the budget capacities, project timescales, and market dynamics.

The particular appropriate form and effectiveness of the new instruments depends to some degree on the nature of the domain. Sometimes, they are too large instruments for some organisations which are part of the constituency, such as SMEs and NGOs. Smaller companies and NGOs make an important contribution in areas like eInclusion, but it has often been hard for them to participate since they do not always have the co-funding capability. (This might be even harder in FP7 where the AC model is removed.)

Throughout the programme, the characteristics of ambitiousness and innovation of IPs came to be better and better exploited, as were the various dimensions of integration. The IP is now found to be effective in assembling critical mass, involving key stakeholders and in achieving the level of system validation for subsequent market exploitation.

The objectives of **Networks of Excellence** (NoE) are clear: they are designed to strengthen scientific and technological excellence on a particular research topic by integrating at a European level the critical mass of resources and expertise needed to provide European leadership and to be a world force in that topic. Nevertheless, the concept seemed not initially to be well understood by the research community. Many early proposals were for little more than simple coordination actions, with no real long-term lasting integration.

Moreover, the implementation of Networks of Excellence took some time to be mastered, particularly with regards to governance and structural integration.

These are difficult problems, not yet fully resolved, and they are the subject of ongoing discussions.

However, most of the funded Networks have reduced fragmentation of research and encouraged collaboration towards standardisation. Participation in NoEs has positive effects in terms of community building, exploitation of excellence in multidisciplinary teams, and creation of awareness in Member States. The JPAs in FP6 NoEs have indeed in some cases been catalysts for co-funding at national level.

The number of NoEs proposals decreased as the implementation progressed through the 6th FP. However, this is not necessarily negative, as it could be attributable to an early saturation of the research capacity in specific sectors. One should not expect a multiplicity of **Networks of Excellence** in any given domain.

For **Specific Supporting Actions**, in some cases it might be more efficient for both the constituency and the Commission to use the Call for Tender mechanism, based on specifications provided by the Commission.

4.2. Simplification

It is clear that the administrative burden on participants in the 6th FP has been heavier that for previous frameworks, contrary to the Commission's intentions. This has been the result of the Decision by the Council and Parliament on the rules for participation; the unfamiliarity of the new instruments; the large numbers of partners in IPs and NoEs, and some aspects of the way the new instruments were implemented: notably an initial requirement for a detailed 12/18 month workplan, an over-complicated structure for proposals and the requirement for audit certificates (albeit now waived for smaller organisations).

The new instruments and procedures were poorly explained at the beginning of the 6th FP, and key documents (model contract and guidelines) were late. These difficulties were recognised in the Marimon report[45], and were promptly acted on by the Commission. Better guidance was produced in 2004, and some administrative improvements were made within the constraints of the legal provisions.

With the new instruments (IPs and NoEs) the total number of projects has been reduced from 3000 in the 5th FP to 1000 in the 6th FP – for similar budgets. (See next section for more detail.) With a similar management overhead per project, this significantly reduced the overall burden on both the Commission and participants.

The larger Integrated projects in the 6th FP and the ETPs associated with them, have provided a sound basis for the Commission to propose 2 of the 5 Joint

[45] http://www.econ.upf.edu/~marimon/reportannexes.pdf

Technology initiatives[46]. These offer the possibility to lighten and simplify the management of European efforts in these two key areas by externalising management to specialised bodies, as well as leveraging a much greater volume of Member State and private funding into a coherent framework.

It nevertheless remains the case that the total volume of data transferred between the consortium and the Commission services during the lifecycle of a project (company registrations, validated bank forms, labour rate data and justifications, cost claims, correspondence justifying cost claims, etc.) is large in comparison with a run-of-the-mill service contract.

[46] In "embedded systems" (ARTEMIS) and nano-electronics (ENIAC).

5. EFFECTIVENESS

The intended effect of increased focus and concentration of effort has been achieved. As a very crude measure, the total number of projects has been reduced by more than 2.5 in comparison with FP5. Specifically, the average project size has more than doubled from 1.8 to 3.9 M€ (and around 9 M€ for IPs). This time, more than 200 projects had a budget higher than 7 M€, representing together almost 60% of the total budget (compared with only 3% in FP5). The portfolio of projects is hence more balanced, allowing both for larger projects where the critical mass of effort is high, and for smaller, more targeted projects that are essential to explore new fields or to address a specific part of the value chain.

In most cases, the objectives of the thematic priority (specific programme) and the work programmes have been met. Perhaps because of the rigour of the proposal selection, and the effectiveness of the annual project reviews, there have been few non-performing projects.

5.1. Consistency and relevance of the work programmes

Three work programmes were adopted: for 2003-4, for 2005-6 and for 2007. They have remained relevant to scientific and technological developments elsewhere, and have reflected advice from ISTAG and the strategic research Agendas emerging from European Technology Platforms. Work-programmes were in line with both mainstream and emerging R&D directions and with the specification of the IST thematic priority.

The priorities set in the work programmes reflected input from consultation meetings, workshops and web-based consultations, from the IST Advisory Group (ISTAG), from the IST programme Committee (ISTC), from the ETPs that were launched already during the course of FP6, from project reviews, from the analysis of impact of completed projects, and from analysis of the results of previous IST Calls - particularly the 'Integrated Portfolio of Projects Analyses (IPPA).

This extensive and intensive consultation led to a strong focus of each Workprogramme on a limited set of Strategic Objectives that needed to be addressed at a European level. The development of the work programmes was supported by technology road-mapping, and focused on sustaining European strengths, opening new opportunities for new markets and standards, combating weaknesses, and promoting a more integrated, systemic approach. Independent verification of the relevance of work programmes is available in some areas: the US NSF, for instance, has recently reshaped its activities on artificial intelligence so that their aims now closely resemble those of the EU programme.

The work programme objectives were formulated in close consultation with industry and the research community, and often built on strong existing initiatives in previous FPs and elsewhere. Indeed, where strong initiatives were already established, the WP could have little impact on content of direction, and it was important that the WP recognised those priorities. By contrast, in merging and rapidly expanding fields such as eHealth, the work-programme helped to focus and thereby bring cohesion to the work. Where, as in that case, a pre-

existing direction was not already established, consultation on the work programme objectives often helped both research and business communities to align their priorities – a process that was further strengthened by the creation of the European Technology Platforms.

In all areas, while the main underlying themes have been kept, the detailed work programme has evolved during the 6th FP. For instance, the 'Grid' research objective was called in two steps: the initial focus on new Grid technologies to solve complex problems allowed to build on European excellence in vertical Grid application areas to build a new generation of Grid technologies; then in the second call the focus was shifted towards Grid developments based on service-oriented architectures, so as to extend the applicability of Grids to applications and services business and industry.

In other areas, successive work-programmes were focussed on specific aspects in order to cover the various aspects that required attention, in order to achieve critical mass of research efforts in each area, rather than touching all aspects at the same time, on each Call, with too little impact. For instance, in the area of ICT for the Environment, and specifically ICT for disaster management, three successive calls addressed systems architecture first; then sensor network and early warning; and finally international cooperation (e.g. tsunami alert systems).

Similar evolution occurred in regard to the strategic objective 'Access to Cultural Heritage' - aimed at making it easier for people to find, understand and experience their cultural heritage. Early in FP6 the foci were on advanced digital libraries services, environments for intelligent heritage and tourism, digitisation processes and workflows, digital restoration and preservation of video material, and digital memory management and exploitation. A later call of FP6 then covered two major topics: first, the conceptualisation and representation of digital cultural and scientific objects, supporting new forms of interactive or creative experiences based on objects of multiple forms and sources; and second, access to and the preservation of cultural and scientific resources, and the tools and systems for long term preservation of digital objects.

Research into technology-enhanced learning shifted through FP6 from improving the efficiency and cost-effectiveness of ICT-based solutions, to a focus on the synergies between individual and organisational learning and improvement of our understanding of how people learn when the processes is mediated by technology.

Research under Cognitive Systems in FP6 started (in Call 2) with support for pioneering research on an ambitious overall goal: the development of engineering principles for intelligent integrated systems. This research was motivated by the proliferation of sensors in IT applications and the consequent requirement need to deal with uncertainty in the form of unexpected events, diverse contexts, novel situations, and so on. Partway through FP6, the emphasis shifted to research into advancing theoretical foundations, offering new methodologies and demonstrating cognitive capabilities through realistic scenarios involving robots. Toward the end of FP6, the strategic objective 'Advanced Robotics' addressed

development of more intelligent, flexible, cost-effective, modular, safe, dependable, robust and user-driven robot systems.

To achieve this evolution, technologies developed and results achieved were constantly reassessed through the means of periodic reviews, participation in scientific conferences, monitoring of work within European Technology Platforms and other industrial and scientific fora to ensure their continuing validity and relevance. In addition continued contact was maintained with the research community throughout the life of the programme, and workshops were held to guarantee the currency of the work programme.

The work programme may evolve for reasons other than technological and developments. In ICT for transport, for instance, despite the strength of the European automotive industry in general, it became apparent during the 6th FP that new Member States were less involved in the priority, mainly due to the fact that most of the automotive industry has its research and development centres in the most industrialised countries. While not strictly part of this report on the 6th FP, it should be noted that to maintain a better balance, it was decided for the 1st Call of FP7 to open research topics also in the service area (goods and people), so as to allow a broader constituency to participate.

However, in fast-moving fields there is a risk that with too infrequent calls for proposals we may not be able to anticipate or respond sufficiently quickly to new research needs or support activities. Better outcomes might be achieved with a more flexible approach.

Due to the limited available budget, work programmes are instrumental to better define and focus the research topics with a potential European dimension. This tighter focus of EU support in the 6th FP has reflected many key areas of scientific and technological advance. However, the enormously wide range of IST developments in recent years has meant that it has not been possible to support all such areas: for some areas previously supported, the community has had to look elsewhere for collaboration frameworks and support, and some key new areas have, as a consequence, developed without EU support and - it is supposed - with lessened EU involvement.

5.2. Exploitation of results

IST-RTD projects in the 6th FP will continue to generate new knowledge for several more years: only half of the funded projects will be finished by the end of 2007. Most will increase European capabilities in developing innovative products and services. Current trends in network use, Web 2.0, networked business processes, digitization, and creativity reinforces the probability of high take-up and commercial exploitation of the research outcomes.

European expertise in OLED lighting has been brought together in FP6 to realize a high brightness, high efficiency flat light source for applications such as signage or LCD backlighting. The very high efficiency is coupled with a lifetime achievement of 5000 hours, making it a very serious prospect for industrial production.

As a result of the European Grid research efforts, the degree of penetration of Grid enabled products and services as well as Grid enabled collaboration within business communities (such as distributed supply chains) has significantly increased. For example, the number of Grid-enabled platforms and cluster computing resources that are made available by vendors and academia from Grid technologies projects to external organisations, for industrial and academic purposes rose +36 % in the last two years of FP6. There was also a 57% increase in the number of grid enabled analysis methods, problem solving environments and workflow tools in industrial application areas such as engineering and pharmaceuticals, and has enabled significant advances in drug design, earth and environment monitoring, biology and medicine, and risk management.

The contribution of IST-RTD projects to exploitation can take many forms, not all the immediate commercialisation of some technology. In the area of personal health monitoring, for instance, projects have piloted solutions and launched a platform on which project results may be exploited commercially. In this same area, the development of the market has been anticipated, leading to establishment of an industrial association to exploit and self-regulate the expected market. Meanwhile, Member States are developing new policies to accommodate personal health monitoring (e.g. in the home care setting) and DG SANCO is working on a new health services directive to establish a legal framework for this market.

However, the major results are at the systemic level, beyond those of individual projects. The *Internet Protocol Multimedia Subsystem*, for instance, emerged as the system of choice of control and service logic for multi-media services: contributions towards its standardisation have been made by many projects. European competitiveness has been enhanced by the development of flexible and intelligent core and metropolitan optical networks, and the achievements in these areas have reinforced Europe's position in standardisation bodies and fora[47]. Such achievements have helped to avoid market fragmentation in, for example, power line communications; mobile television (DVB-H and DVB-SH); ultra-wide band wireless communications (where spectrum harmonisation was facilitated), and in spectrum allocations for 4G systems.

Contributions to international frameworks and standardisation bodies are now among the most important routes to European leadership in new global markets. IST RTD in FP6 has led, for instance, to a proposed standard for safety-critical Java, supporting development of real-time embedded systems on an architecture-neutral platform, that is expected to be established in the market by the end of 2008.

The range of such standardisation bodies has increased enormously during the 5th and 6th FPs. For example, in addition to projects (and standards) dealing with the harder ICT technology issues, projects concerned with environmental monitoring have contributed specifications to the Open Geospatial Consortium, and projects concerned with monitoring the transport of dangerous goods have engaged with

[47] ISO, ETSI, ITU, CEPT, OIF, OMG, IETF, IRTF, DVB, MPEG, IEEE, OMA, etc

the UN-ECE Regulatory Committee. As a consequence, this Committee is exploring, together with DG TREN, the setting up of a legal basis for possible mandatory system deployment of the monitoring platform developed within the research theme.

Projects have been major contributors to the processes of standards development with engagement with (for just some examples) ISO, ETSI, ITU, CEPT, OASIS, OGF, OMA, OMG, IETF, IRTF, DVB, MPEG, IEEE, and W3C. A new ETSI Technical Committee focusing on Grid interoperability standards has been established with the facilitation of industrial stakeholders involved in Grid technologies projects. (This committee is strongly endorsed by DG ENTR).

Work initiated in FP6 is also expected to lead to significant results in the policy context. An illustration of this contribution is the work on RFID and the Internet of Things, which has been the subject of a Commission Communication (and much concern in the popular media) and which is expected to lead to a Commission Recommendation on RFID concerning, in particular, security and privacy aspects.

The outputs of projects have been systematically monitored since 2005: Over 18,991 scientific publications and 511 patent applications have been reported in 2005 and 2006.

Research also opens up new areas for investigation and development. For example, the IST-RTD on biomedical informatics has led to new interest in better management of cancer treatments[48] and the development of "in silico" environments for drug development. The 6th FP support to IST-RTD on *Artificial Cognitive Systems* formed a new research community which has gained momentum and evolved into a fully fledged scientific discipline. RTD on semantic technologies was also new during FP6 but is now well-established - a search on Google now finds 32 million 'hits'. Most key players have been involved in the EU-RTD and European research enjoys a worldwide reputation.

IST-RTD achievements have been widely reported and publicised - especially beyond the constituency that is already familiar with the Framework Programmes. Some attempts to reach a wider audience have been more successful than others.

IST Results is an online editorial service established by DG INFSO to raise the visibility of IST-funded research results and to encourage the take-up of innovations. Composed of editors, journalists, web designers and marketing experts, the service produces feature articles and news items on results emerging from the IST programme. The articles and news are published on the IST Results website[49]. The website content is actively marketed to key audiences, including online and print media, with the aim of encouraging maximum republication and dissemination. Since publication started in March 2003, some 1500 feature

[48] 'Advancing Clinico Genomic Trials' (http://www.eu-acgt.org/)

[49] http://istresults.cordis.lu

articles and 3,600 news items have been published, covering about 2,000 IST projects. Consultation of the IST Results website has risen steadily since its launch. The website now registers over 100,000 visits and 240,000 page views per month. Its articles have frequently been taken up in the "Worth watching" column of FT.com, the online version of the Financial Times.

IST-TV had, as its target audience, the general public. It was moderately successful in having a range of project-related videos broadcast on mainstream television. However, this was not easy to achieve, and takers were more usually found in the ranks of small and under-funded broadcasters in less wealthy member states, rather than - as had been hoped - the major TV stations of the larger member states. The heavy marketing investment needed made the costs of this project unacceptably high.

FUTURIS is a bi-weekly research magazine produced through the co-operation of DG INFSO, DG RTD and EuroNews, Its intended audience is again the general public. Since May 2006 there have been over 30 reports in total – ten exclusively on ICT-subjects and three additional reports (under RTD-responsibility) which included INFSO-projects. These were broadcast at least 20 times on EuroNews (in seven languages) and had an average audience of 1.000.000 viewers[50]. Further dissemination activities resulted in multiple re-broadcasts by other European and international TV channels, including ARD, BBC, RAI, TVE, TVP, and YLE, adding an additional audience of 1.5 to 5 million viewers[51] . All Futuris-stories are published on various websites, Special Star Projects website, INFSO Audiovisual Library, and EuroNews, and the three partners have produced and disseminated a series of special Futuris DVDs – one of which is exclusively dedicated to ICT-stories.

An independent observatory is analysing the impacts of projects in the 5th FP and will address those from the 6th FP from 2008.

[50] Official audience meta data by GfK, Médiamétrie and others

[51] Figures provided by the respective channels

6. UTILITY

The benefit of participation in EU RTD has been as much in provision of a mechanism for co-operation between competing companies in pre-competitive RTD, in involving suppliers in addressing new technology integration at an early stage, in facilitation of multidisciplinary RTD (e.g. biomedical informatics), and in enabling more adventurousness and risk-taking in exploration of new ideas, as in simply enabling specific research or technology developments that could not be achieved collaboratively at EU-level.

Moreover, the utility of the research activities supported by the FP must be accompanied by activities (coordination and support) that ensure the highest possible degree of take up of the research results. For this reason, IST activities in the 6th FP have contributed to policy making in the sense that barriers to the market have been identified at an early stage with a view to permit new technological options, new services and new applications to be developed with a European dimension. Particular examples include the drive towards a digitally-based service economy calling for specific standardisation efforts where the NESSI ETP established during 6th FP has already played an important role; the definition of common visions and strategies for Enterprise Interoperability and for advanced RFID technologies and applications; and the innovative use of Digital Ecosystems technologies for SMEs and regional development.

The other side of the policy coin is that other EU policies have been realised with the support of IST-RTD in ways that could not have been achieved otherwise - for instance, the implementation of DG AIDCO financed projects to extend interconnection of research and education networks (GÉANT) to other parts of the world, namely the interconnection with Mediterranean, Latin America and Asia regions.

In some areas, EU support has enabled major new business initiatives to take-off, in ways that would otherwise not have been possible. For example, collaborative RTD on wireless-sensor networks[52] has led to major breakthroughs and enabled a new company (Particle GmbH) to be spun off. The company has won several awards[53] and is already one of the top 50 German start-ups.

In the telecommunications world, one particularly important challenge will be to efficiently manage and control the optimisation of radio resource and spectrum usage in the context of heterogeneous systems, encompassing the space, time, multi-access and multi-owner dimensions. The development of technologies to manage and control spectrum usage in such systems can only be done at European level. Without the RTD support in the 5th and 6th FPs, it would have not been possible.

Typically, participants have seen the Framework Programme as the primary mechanism to support RTD between partners from different Member States, notwithstanding the existence of Eureka and other special arrangements. In addition, in the case of Integrated Projects led by the automotive industry, the sector has seen participation in the Framework Programme as a mechanism to achieve (and get support for) pre-

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52 http://www.cobis-online.de

53 http://www.particle-computer.de/en/Company/index.php

competitive RTD involving competitors. However, referring back to efficiency, the seriousness of purpose of the proposers to perform coherent, synergistic RTD is not always apparent until quite late in the process - during negotiations and in the first year of activity, for instance.

EU support has also brought together innovations in biology and communications in ways that are not possible in the (generally) more compartmentalised programmes of Member States. Multidisciplinary research involving both the ICT and Life science domains has led to new solutions to ICT problems by studying natural information processing techniques - in particular by 'reverse engineering' of the brain - and implementing these using hybrid analogue/digital VLSI in silicon.

Support for RTD on organic and large-area electronics has brought together stakeholders who would not otherwise have collaborated. In a study of the impact of FP5 projects, between 40% and 60% of participants reported that they would not have achieved the same results without participation in 6th FP projects.

However, the impact of FP funding can be strongly increased with flanking initiatives that provide the visibility required to move forward social and economical conditions determining the take-up (or not) of new technologies or methods. The instruments and mechanisms of the 6th FP programme were primarily designed to address technological challenges, though coordination and direct support activities for research could also be implemented. However, issues of an industrial nature, particularly important for emerging areas where a culture of cooperation does not exist, have needed to be addressed by specific initiatives outside the present working mechanisms of the programme. It is important to demonstrate the impact on society at large (social, economic or strategic). This requires an effort to valorise the output of the projects, not one by one, but looking at a cluster of projects, and not just projects funded under a particular RTD priority, but also other priorities under the FP and national RTD programmes.

This has been demonstrated with the eSafety Initiative, with Roaming, and with RFID. In the domain of organic and large area electronics, mentioned above, the various stakeholders have been brought together, including industrialists with conflicting interests and representatives of national programmes, to address issues such as fragmentation, dispersion of research, barriers to the creation of start-up and spin-off companies, and lack of coordination of national/EU research. They are now participating in periodic 'OLA stakeholders' workshops'.

Integration of the digital libraries research community has placed EU institutions and some companies at least at pair with the USA, which would have been impossible without EC funding. In technology-enhanced learning, initiatives such as iClass would have not taken place without the gathering – at European level - of excellences in different scientific disciplines needed to approach the subject. The projects on brain, games and learning, involving neuroscientists, physiologists and computers scientists, are another example of the catalytic role of EU projects in facilitating multidisciplinary research.

6.1. Unexpected developments

The interaction between disciplines in some larger integrated projects has also generated unexpected innovations: for example, in a very low power variant of Bluetooth communication[54].

Project clusters have led to the emergence of new topics - such as "flexible electronics"[55] - with their own (new) communities.

Another somewhat unexpected result is the extent to which European equipment manufacturers and network operators have moved during the course of the 6th FP from consideration of different communication modalities as separate and competing to a common vision of the convergence of mobile, wireless and broadband communications to deliver new services to European citizens.

A fundamental achievement is the consolidation of Internet protocol as the basis for all services. This requires a full revision of network architectures and technologies, a close integration of IP and transport layers including advanced Control Plane inter-working, and an easy, automated management of optical circuits for fast provisioning and restoration. The vision is to provide a powerful control layer to the current Internet, taking into account of the heterogeneity with respect to technology and business environment, but also addressing the Internet of the Future by providing the novel idea of network composition and proved split between address and identity through the innovative Node Id architecture. The work has gained considerable attention from the Future Internet community in the US, especially from the FIND and GENI programme management. As a consequence of these important developments, research in these areas has been combined in FP7, in the Objective "Network of the Future".

The Situated and Autonomic Communications Proactive Initiative has been very influential both inside and outside the ICT programme. It had a substantial influence on the formulation of the Future Internet Research and Experimentation Initiative[56]. This is now a major European activity in the area of future networking paradigms, and provides significant market opportunities for new technologies based on new architectures that overcome current limitations of deployed equipment. The Situated and Autonomic Communications Proactive Initiative influenced this think tank to look more at longer term challenges.

In parallel, the High Performance Computing in Europe Taskforce was established with the aim of developing a high-end supercomputing infrastructure in Europe. This group comprises officials from national sponsoring agencies for science and research, managers of supercomputing centres and national infrastructure organisations. Working in collaboration with ESFRI and e-IRG the Task Force has produce a roadmap for new Research Infrastructures.

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54 IP MIMOSA-BTLEE: Bluetooth Low End Extension

55 http://www.imcc.be/flex-stretch

56 http://www.panlab.net/FIRE.html

The focus in the 6th FP on eHealth has generated a larger than expected interest of the pharmaceutical industry that has not previously participated in the RTD of the Framework Programmes. The research in this theme during the 6th FP has also exposed the imperative need to solve the legal framework governing the reimbursement and secondary use of patient data before the planned date of 2009.

Another unforeseen development of the 6th FP has been the emergence of the concept of Global Virtual Research Communities. The main objective of a Global Virtual Research Community is to link advanced science to its supporting and underlying infrastructures in a way that attracts the best minds and the best science projects to work on the best research infrastructure. In turn, this poses research challenges relating to the need to understand and 'manage' (to the extent that is possible) the consequent evolved organisational models to make all the positive forces resonate and to mitigate all potential barriers.

7. CONTINUITY OF IMPACTS

Most participants report a major benefit in new knowledge, skills and contacts for collaboration. This increased human capital persists: the experience and knowledge is retained through the subsequent careers of the scientists and engineers.

Over the sequence of FPs, co-operation networks in specific areas have become stable. They not only persist through several FPs, but become the core of wider collaborations such as in the European Technology Platforms or frameworks such as the eSafety Forum. Establishment of Institutes and Associations emanating directly from NoEs, such as the European Association of Technology Enhanced Learning[57], will continue to operate after the end of the initial support to contribute to realisation of the ambition for permanent restructuring.

The common research agendas established, for example, through European Technology Platforms and Networks of Excellence will also live beyond the 6th FP and the projects within the 6th FP. In turn, they will generate RTD activity and deployment of RTD-derived technologies and applications, much of it outside the Framework Programmes, which will have long-lasting impact.

In some areas, growing awareness of the strategic importance of a wider range of new ideas by major industrial players led to a sustained reinforcement of collaborations with academia. The increasing importance of ICT-enabled innovations across the whole economy has also been demonstrated by the greater participation of leading companies from other sectors (transport, pharmaceuticals, etc) and public authorities. The pressures of competition and efficiency will now contribute to sustaining these wider collaborations.

However, IST-RTD remains a key enabler, as demonstrated by the influence of the programme on the formation of ETPs. There is a danger that coherence and momentum will be lost, and the research community dispersed if EU-RTD in some areas is not maintained. Without EU intervention, it is very likely that access to new ideas will become the privilege of a handful of large organisations; the European dimension would be lost, and the flow of new ideas from academia to industry would be compromised. Only the EU framework can provide harmonised solutions and the markets where new technologies can be exploited. This calls for cooperation across a range of stakeholders who individually do not have the resources or the competence to address all aspects of ICT systems and their applications.

Examples where this has been achieved include the research areas of wearable health systems and biomedical informatics. These are entirely new disciplines, with clear structuring impacts in the R&D community.

Large scale eHealth pilots that demonstrated to healthcare providers the delivery of better care by proper use of eHealth solutions in combination with organisational changes, legal framework and skills, will have a lasting impact on the organisation and sustainability of health delivery.

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[57] See: www.ea-tel.eu

The work in the 6th FP on research infrastructures has enabled the design, deployment and validation of advanced network and Grid technologies that are precursors to future upgrades of the European research infrastructure. The lasting impact of these investments is evident in the continued and increasing of use of the infrastructure by European researchers.

Research has impacted the nature and need for research itself. The ICT–Bio convergence that has been explored in the biomedical informatics area has lead to numerous challenges for ICT in the areas of security and privacy, middleware for "Health-grid" applications, simulation and visualisation of disease related processes. These in turn have knock-on research implications for computational modelling techniques and ICT hardware to support *highly* resource-intensive models.

Similarly, research with a longer-term view has renewed the ICT research agenda elsewhere. Some of the FET initiatives in FP6, like Bio-ICT and quantum computing, have been followed by NSF and DARPA. Research areas first explored in FET have been successfully transferred into mainstream ICT research challenges, e.g. new computing and networking paradigms, quantum cryptography, photonics and advanced robotics. Without any claim to direct causality, it is interesting to observe that the US's NSF has recently followed the FET approach, announcing a shift towards transformative research - *"research that has the capacity to revolutionize existing fields, cause paradigm shifts, support discovery, and lead to radically new technologies"*. In such ways, longer-term research can have long-lasting impacts beyond specific projects and programme themes.

Annexes

I. Contribution from Directorate A "Audiovisual, Media, Internet"

II. Contribution from Directorate D "Converged Networks and Services"

III. Contribution from Directorate E "Digital Content and Cognitive Systems"

IV. Contribution from Directorate F "Emerging Technologies and Infrastructures

V. Contribution from Directorate G "Components and Systems"

VI. Contribution from Directorate H "ICT Addressing Societal Challenges"

VII. Additional material provided by the Units C2, C3, C4 and C5 within Directorate C "Lisbon Strategy and Policies for the Information Society"

The above Annexes i.e. contributions and additional material, are available on the web-based workspace for the "Ex-post evaluation of IST Research in the 6th FP" at:
http://circa.europa.eu/Public/irc/infso/istevaluation/home