> Foreword

Boosting Europe's investment in research, innovation and education to create growth and new jobs is at the heart of the revitalised Lisbon strategy. To this end, the Member States have set a target – the 'Barcelona objective' – to invest 3% of GDP in research and development by 2010. While we are still some way off, with the latest figures showing investment of 1.9% of GDP, there are nonetheless some encouraging signs of both businesses and governments increasing their research spending. Member States and the Commission are united in their intention to create an environment that supports business investment in R&D and provides incentives for investing more in the knowledge economy.

It is equally important how this new investment is made. As well as under-funding, the second problem Europe faces is its divided research efforts. It is here where research at European level has real added value because the Framework Programme can achieve impacts which are less possible nationally: assembling critical mass of knowledge and resources; enabling the flow of ideas, knowledge, and researchers across the European Union; overcoming the fragmentation of research policies and activities across Europe; driving excellence through pan-European competition; developing mobility, training and careers; and supporting European strategies on issues of common interest such as research infrastructures and international scientific cooperation.

Research in information and communication technologies (ICT) is a key part of this agenda. Through ICT research in the Seventh Framework Programme (FP7), the Commission will encourage the transformation of technological progress into innovative applications and services in the public and private sectors that address societal needs. It will support creative, targeted approaches – such as the European Technology Platforms and Joint Technology Initiatives – that build scale through public-private partnerships to mobilise the know-how, capabilities and financial resources of industry and research in strategic areas. Strategic research is prioritised in areas where European added value is greatest and where impact on growth and jobs is highest.

As well as being a research theme in its own right, ICT are central to the way science is done. From biotechnology and medicine, to engineering design, high-energy physics and environmental sciences, future progress depends critically on a well-equipped ICT-based eInfrastructure that is able to store and process vast amounts of data. FP7 will make further investments in this eScience infrastructure, building on Europe's world-leading position.

We welcome this brochure as an illustration of how research and innovation in ICT are contributing to a competitive and world-class research community in Europe.

Viviane Reding

European Commissioner for Information Society and Media

Janez Potočnik

European Commissioner for Science and Research

> Challenges for Science and Research

Science and technology are essential to today's knowledge economy. The competitiveness of the EU and the realisation of growth and jobs depend to a great extent on its ability to harness scientific and technological breakthroughs. Research and development (R&D) also plays an essential role in supporting other EU policies, in areas such as consumer protection and protection of the environment. In short, the individual and collective well-being of European citizens depends on world class research and innovation.

To keep the Union on target to becoming the world's most dynamic knowledge-based economy, Member States have set an objective – the so-called Barcelona Objective – to increase their spending on research to at least 3% of GDP. Overall, the EU-25 has managed to increase marginally the amount it spends on R&D from 1.92% in 1999 to 1.95% in 2005. But on average the Union still lags behind its main competitors, Japan (3.54%) and the USA (2.76%). On innovation too, the *2005 European Innovation Scoreboard* – a benchmarking tool – shows on almost all measures that the EU's innovation performance remains weaker than its main international competitors. Meanwhile, emerging countries like China and India are fast becoming world-class centres of research and innovation.

At the same time, the research world itself is changing fundamentally. High-level research is becoming more complex and interdisciplinary, is increasingly costly, and requires a constantly increasing "critical mass". Hardly any research team or research laboratory, or any company can reasonably claim to be able to respond to these challenges.

Even entire Member States find it increasingly difficult to be active and play a leading role in the many important areas of scientific and technological advance. Cooperation at different levels and better coordination between national and European policies are therefore essential for success in this global research environment.

Europe has a long standing tradition of excellence in research and innovation, and European teams continue to lead progress in many fields of science and technology. However our centres of excellence are scattered across the continent and all too often their efforts fail to add up in the absence of adequate networking and cooperation. To overcome this fragmentation, we must build the European Research Area (ERA) as a "common market" for research and innovation so as to increase the coherence and impact of Europe's research efforts.

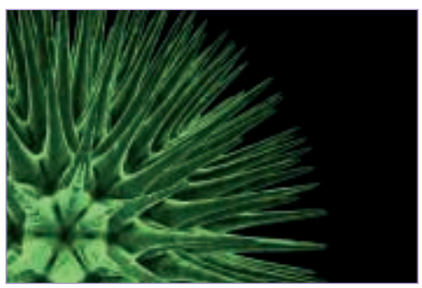
The ERA aims to achieve better use of scientific resources and facilities at the European level, more dynamic private investment in R&D, increased human resources and researcher mobility, as well as providing conditions more conducive for a research area of 'shared values'. It provides a platform to pool dispersed resources and expertise and to intensify research efforts at EU level, coordinating them with national and international initiatives.

> Research Policy

Since the launch of the First Framework Programme for research, in 1984, the Union has played a leading role in setting up and implementing multidisciplinary research and cooperative activities in Europe and beyond. Concentrating on high-quality research, the EU's Research programmes both focus and integrate Europe's science and research and were the first to include the new Member States in collaborative projects.

The launch of the Seventh Framework Programme (FP7) will give new impetus to increase Europe's growth and competitiveness, recognising that knowledge is Europe's greatest resource. It includes a number of innovations to ensure research meets the needs of the European economy and society in the 21st century. These include:

- The programme runs for seven years, from 2007-2013, so providing a stable framework for European research policy.
- Greater emphasis than in the past on research that is relevant to the needs of European industry, to help it compete internationally and develop its role as a world leader in certain sectors.
- For the first time, the programme provides support for the best in European investigator-driven research, with the creation of a European Research Council.
- Making participation in the programme simpler and easier, through measures addressing the procedures, plus a rationalisation of instruments.



Focus will be on excellence throughout the programme, a key requirement if it is to play its role in developing Europe's global competitiveness.

The Union's own research activities are only part of the picture, however. In fact, almost 90% of all public research funding in Europe is spent by national and regional research programmes. To ensure this funding is used to best advantage, the Commission has tabled an integrated action plan for research and innovation[1], which calls for a major upgrade of the conditions for the knowledge economy in Europe. The Plan sets out the future strategy to boost Europe's investment in research in line with the Barcelona 3% objective and reflects the high priority given to research and innovation in the Lisbon strategy for growth and jobs. Specifically, the Plan includes commitments to better mobilise all EU funds and instruments to support research and innovation, including those from national programmes.

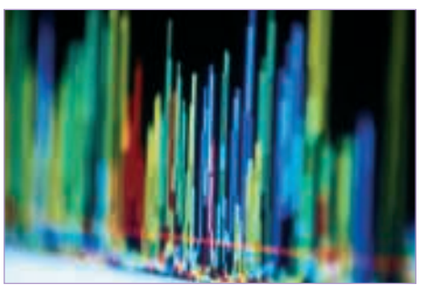
Another key development in this context is the European Technology Platforms, industry-led initiatives which bring together stakeholders around common objectives. Rapidly evolving into "champions for growth", these have the capacity to address a wide range of innovation challenges, from the laboratory to the market, in a coherent way. The results of this research can be commercialised, enabling Europe to increase its innovative capacity to transform excellence in science into added economic value.

[1]Communication on More Research and Innovation – A Common Approach, COM(2005) 488 final

> Where the Information Society meets Science and Research

Information and communication technologies (ICT) are central to modern science. Collaboration is an established feature of scientific research and is increasingly undertaken over electronic networks. These allow researchers not only to communicate with their fellow scientists but also to access resources such as very large data collections, scientific experiments and high-performance computing.

Thus, the availability of an infrastructure based on advanced data communications, computing and information (eInfrastructure) is indispensable for conducting high-quality research and demonstrating progress in most fields of science and engineering. The mapping of the human genome and the discovery of new elementary particles are just two of the many examples of important scientific findings that could only have taken place with the support of advanced computational, data storage and network technologies. This research infrastructure comprises all the tools, facilities and resources needed for advanced collaboration and is already fundamental for scientists around the globe.



Another key trend is that the boundaries between ICT itself and other scientific disciplines are blurring. The prospects for major advances rely increasingly on exploration at the frontiers between ICT and other fields. This accelerated integration of ICT with other areas of science and technology will be at the origin of the next revolutions in medicine, energy, environment and many other areas.

Information Society Activities

Research for eInfrastructure

The costs and efforts required to establish and efficiently use world-leading research infrastructures in different fields of science are, in many cases, so high that they are beyond the capability of individual Member States' investments and need to be shared at the European or even global level.

In FP6, significant budget was allocated to upgrade the European research and education network GÉANT, and to deploy grid-based infrastructures. With a two-layer infrastructure, based on GÉANT and grid middleware, Europe is implementing a world pioneering eInfrastructure that will revolutionise the way in which ICT resources are shared. This eInfrastructure is a basic foundation for the European Research Area and is critical to ensure that Europe continues to be an attractive region for research globally.

Building upon the world leadership demonstrated with the GÉANT and grid initiatives under FP6, Europe will continue to sustain and expand this effort in the future to retain world-class research infrastructures. Through the Research Infrastructures action of the Capacities programme, FP7 will support the further strengthening of this eInfrastructure as well as the creation of pan-European virtual centres of excellence and research laboratories based on it. On top of communication and computing capabilities, future ICT research will provide technologies for collaboration, knowledge-sharing and experimentation in various areas of science and engineering.

The aim is to develop a new research environment in which all European researchers have an easy-to-use controlled access to the necessary scientific facilities anywhere in the world. This advanced eInfrastructure will support more intense collaborations between research centres and their researchers in 'virtual research communities', enabling worldwide sustainable partnerships in all fields of science.

Other Research Activities

The explosion of scientific data influences the efficiency with which research communities are able to manage, use, share and maintain data to produce invaluable scientific results. Research into digital repositories of scientific data is an emerging area for FP7, representing the meeting point of a large number of disciplines and fields, i.e. data management and annotation, information retrieval, library sciences, document management, information systems, image processing, artificial intelligence, human-computer interaction, and others. Relevant actions will also be funded under **eContent*plus***, which aims to improve the accessibility and usability of European cultural and scientific content.

Increasingly, the most radical breakthroughs come at the intersection between scientific disciplines. Hence, research is also undertaken to bridge ICT and other fields, for example those related to new materials, bio- and life sciences and from the knowledge base of the cognitive, biological and social sciences. In FP6 this pathfinder research was supported through the IST Programme's **Future and Emerging Technologies (FET)** action, which pursued pioneering, visionary research with a long time horizon. These activities will be continued and expanded in FP7.

Policy-oriented Initiatives

As well as the technological issues, the development of eInfrastructure and eScience presents major policy challenges: how to stimulate European and national initiatives; how to tackle the organisational aspects induced by the ability to share resources, etc. Here, DG Information Society and Media either leads or participates in several policy-oriented initiatives:

- The eInfrastructure Reflection Group (www.e-irg.org) brings together delegates from the research ministries of the Member States to define policies and share best practices.
- The European Strategy Forum on Research Infrastructure (www.cordis.lu/era/esfri/) brings together national representatives to agree common approaches to policy on research infrastructures.
- The European Network Policy Group (www.enpg.org) is a forum for the national funding authorities for research networking.

> Bringing Down the Borders to Transnational ICT Research

The Commission and Member States are working closely together to make a European Research Area in ICT a reality.

Policy Context

Europe has a strong position in many areas of information and communication technologies (ICT) and enjoys a high reputation in ICT research. But fragmentation of efforts, limited cooperation between key players and lack of information exchange about activities in other countries can sometimes lead to loss of efficiency, duplication of effort and missed opportunities.

Better coordination across the disparate programmes and initiatives in different countries is needed if Europe is to realise its full research potential. The policy of establishing a European Research Area (ERA) intends to coordinate these national research policies in the direction of shared objectives, expertise and resources.

The ERA has been a key feature of European research policy since 2000. Its underpinning idea is that the issues and challenges of the future cannot be met without much greater integration of Europe's research efforts and capacities.

It aims to move Europe up a gear by introducing a coherent and concerted approach at Union level from which genuine joint strategies can be developed. With the ERA Europe gives itself the resources with which to fully exploit its exceptional potential and to realise the competitive and vibrant knowledge-based economy foreseen in the Lisbon strategy.

The central place of the ERA in European research policy was reiterated most recently in the proposal for the Seventh Research Framework Programme and in the 2005 *Communication on 'More Research and Innovation – A Common Approach'*, which set out the future strategy to boost Europe's investment in research in line with the Barcelona 3% objective.

The Communication proposes tighter coupling between actions to invest in research and those to promote innovation. This includes commitments to better mobilise all EU funds and instruments to support research and innovation, including from national programmes, and to enhance national policies through transnational cooperation.

Coordination for the European Research Area in ICT

In the ICT sphere, the FP6 project CISTRANA is helping to make all this reality through better coordination of national research and development efforts in ICT. In doing so it is developing a clearer picture of the research funding and investment landscape.

CISTRANA is mapping national research efforts in ICT and establishing a portal with comparable information on national ICT R&D policies and programmes across Europe. In addition, the project identifies ICT research topics and strategic themes where transnational cooperation is essential, aiming to establish sustainable mechanisms for building coordination initiatives between different Member States.

Although a number of different policy and funding structures currently exist, CISTRANA's initial survey showed there is room to deepen coherence and coordination. Programmes in most countries were already open to transnational cooperation in principle, but many had yet to put this into practice. Often there was no real incentive to cooperate, no motivation to pool resources and little sense of strategic collaboration. The differing structures and systems employed across countries to fund research pose yet another challenge, making programmes difficult to compare and join together.

Towards Enhanced Cooperation

Nevertheless, coordination between the various EU administrations is demonstrably on the rise. Member States have already established a comprehensive framework to address greater coordination at both policy and programme level (see box).

In addition, under IST-FP6 the Commission has funded 25 ICT ERA coordination actions. These look at key ICT themes, so as to plan for the future and build common research frameworks. The actions involve funding bodies in the coordination of ICT programmes and they also develop R&D roadmaps and map R&D actors in ICT sectors. In some cases these measures are linked with ICT-related European Technology Platforms or with the planning of Joint Technology Initiatives and Article 169 initiatives proposed by the Commission for FP7.

Looking further ahead, coordination has become an integral element within the thematic activities for the coming Seventh Framework Programme (FP7), the next phase in European-level research. This integration underlines the significance policy-makers attach to greater coordination.

Building a European Vision for ICT Research

The EU's own Research Framework Programme is a small fraction of all research funding – public and private – across the EU. In fact, almost 90% of all public ICT research funding in Europe is spent by national and regional research programmes.

As part of the second pillar of the i2010 Initiative, therefore, the Commission has launched the "Vienna Process", named after an initial conference on these issues held in Vienna in March 2006. This aims to improve the coordination of:

- **Policies and visions for ICT research across Europe**: helping identify where Europe should focus and coordinate its research efforts. In particular, the Commission receives input on these issues from the National IST RTD Directors Forum (an informal forum of national and European decision-makers), and the IST Advisory Group (ISTAG – an expert group set up under the IST Programme).
- **National and European ICT research programmes**: working on the 'nuts and bolts' of coordinating specific national research programmes across Europe.

> PROJECT DETAILS

CISTRANA - Coordination of IST Research and National Activities

cistrana@dlr.de • www.cistrana.org

> Platforms for Common Action

Nine European Technology Platforms in ICT are helping European industry to coordinate its research efforts and to develop common views on future research needs and requirements.

Policy Context

To remain competitive, European industry needs to specialise more in high-technology areas. Investment in research must be increased, coordination across Europe enhanced and the technological content of industrial activity raised. There are also barriers to the development, deployment and use of new technologies.

European Technology Platforms (ETPs) address these challenges. They are multi-stakeholder initiatives, led by industry, to develop shared visions in areas crucial to Europe's future growth, competitiveness and sustainability. Stakeholders work together to define medium to long-term research and technological development objectives and lay down markers for achieving them.

The ETPs are a means of focusing research efforts on areas with a high degree of industrial relevance and promising market potential. They will reduce fragmentation of research and development (R&D) activities and help mobilise public and private funding sources. The ETPs will have a positive impact on a wide range of policies and the achievement of their objectives will significantly improve the daily lives of European citizens in many areas.

The Commission's 2005 Communication on research policy calls for a more joined up approach to research and innovation in Europe to enable us to compete better on the world stage. The ETPs are one means of achieving this, helping to ensure that EU research priorities are better aligned to industry's needs. They cover the whole economic value chain, ensuring that knowledge generated through research is transformed into technologies and processes, and ultimately into marketable products and services.

European Technology Platforms in ICT

ETPs adopt a longstanding, familiar approach commonly used in the ICT domain, as most major European successes are the results of partnerships and consensus building exercises between industry and academia. Indeed this is how Europe built its industrial strengths in areas such as mobile communications, digital broadcasting and in several areas of microelectronics.

Industrial and academic research communities work together within the ETPs to coordinate their research and tailor it to a common "strategic research agenda" (SRA). This sets out research goals, time frames and action plans for technological advances that are relevant to industry and society. SRAs aim to mobilise a critical mass of national and European public and private resources.

Typically, SRAs seek to overcome barriers to the development, deployment and use of new technologies. Examples of such barriers might include how research is organised, outdated regulations, lack of common technical standards or a need for new ones, shortfall in funding, disinclination to accept new technologies, or a shortage of skills and training. ETP stakeholders agree to support their SRA financially and to monitor its implementation.

So far, nine ETPs have been launched in the ICT domain. These are:

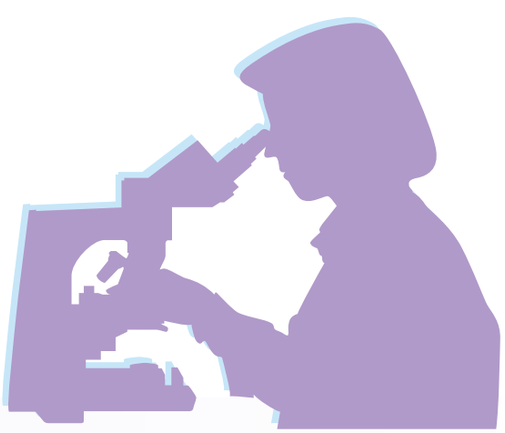
- **ARTEMIS**, focusing on the development and large-scale deployment of embedded systems technologies.
- **eMobility**, which aims to reinforce Europe's leadership in mobile and wireless communications and services and to master the future development of relevant technologies.
- **ENIAC**, focusing on the revolutionary transition from microelectronics to nanoelectronics and the resulting applications.
- **EUROP**, which aims to boost the development of robotic businesses within Europe and at bringing the benefits of capable robots to the service of European citizens.
- **EPoSS**, which looks at smart systems integration (those combining sensing, processing and actuating functions) and related areas of micro- and nano-technology.

- **ISI**, focusing on all aspects of satellite communications, including broadcasting, broadband, and mobile applications, and their convergence.
- **NEM**, focusing on the convergence between broadband, mobile and new media technologies and the resulting commercial opportunities.
- **NESSI**, focusing on the role of software and service-oriented architectures in the emerging service-oriented economy in Europe.
- **Photonics21**, focusing on developments in photonics and establishing European leadership in the deployment of photonics in key industrial areas.

Two of these Platforms, ARTEMIS and ENIAC, are planned to be proposed as Joint Technology Initiatives under FP7 using Article 171 of the Treaty. These will allow Europe to pool together the required funding from the private sector, from the Member States and from the Community to support the Platforms' research agendas. They will facilitate the cooperation between all stakeholders in order to improve our competitive position and respond to Europe's societal needs.

In the ICT sphere, the Platforms are likely to be especially important in promoting interoperability and standards, which have been identified as an essential part of the jigsaw when it comes to turning state-of-the-art R&D into market success. Most of the Platforms are already in dialogue with standardisation organisations on this issue.

Early experience from the platforms in ICT is positive. ETPs have successfully mobilised players and created a momentum at the highest industrial and political levels. In the area of embedded systems for example, the ARTEMIS Platform will position Europe in the lead not only in supplying ICT products and services but also in using them in important industrial sectors such as automotive, aerospace, medical equipment and industrial automation.



> PROJECT DETAILS

ARTEMIS - Advanced Research and Technology for Embedded Intelligence and Systems
www.artemis-office.org
eMobility - Mobile and Wireless Communications Technology Platform
www.emobility.eu.org
ENIAC - European Nanoelectronics Initiative Advisory Council
http://cordis.europa.eu/ist/eniac/
EPoSS - European Technology Platform on Smart Systems Integration
www.smart-systems-integration.org
EUROP - European Robotics Platform
www.roboticsplatform.eu.com
ISI - The Integral Satcom Initiative
www.isi-initiative.eu.org
NEM - Networked and Electronic Media European Technology Platform
www.nem-initiative.org
NESSI - Networked European Software and Services Initiative
www.nessi-europe.com
Photonics21 - Photonics for the 21st Century
www.photonics21.org

> eInfrastructure: A Key Tool for Global Science

ICT-based research infrastructures are essential for Europe's researchers to stay at the forefront of eScience.

Policy Context

Cross-border collaboration is now an established feature of the research landscape. In almost all disciplines, from astronomy and high-energy physics, to molecular biology, climate modelling and the humanities, researchers from different institutions and different fields of science are working together across organisational and national boundaries. In industrial contexts, too, collaboration has become the norm, with researchers from different continents working together to share ideas, facilities and results. Thus, research is not just becoming more European in nature; it is also becoming more global.

High-capacity communications networks are essential to these global scientific collaborations. These advanced facilities help keep researchers at the forefront of their respective fields of research, retaining and developing academic and industrial expertise in Europe and ultimately boosting the productivity and competitiveness of European businesses in global markets.

The European Council has highlighted the importance of speeding up the roll-out of European electronic communication networks and of increasing investment in human capital. This commitment was reflected in the significant budget allocated to upgrade the European research and education network, GÉANT, and to deploy grid-based infrastructures in the Sixth Framework Programme (FP6).

Further investments will be made under the Capacities programme of the Seventh Framework Programme (FP7) as part of measures to optimise the growth and development of pan-European research infrastructures in all fields of science and technology. The FP7 proposals specifically recognise the enabling role of electronic research infrastructures, high-capacity and performance communication, grid and high-end computing capabilities.

From Research Networks to eInfrastructure

For many years Europe's national research and education networks have been linked together, via a high-speed, high-capacity network called GÉANT. Past generations of this pan-European infrastructure have clearly demonstrated the multiplier effect of high-quality, high-bandwidth networks. In connecting researchers to each other, research networking enables activities that were previously impossible or inefficient. In addition, it stimulates new working methods based on shared use of scientific resources.

The latest upgrade, known as GÉANT2, has further improved the performance of the network infrastructure, giving Europe the world's most advanced research network. The GÉANT2 network connects over 30 million users in 34 countries and has a total network footprint of over 50,000km. Many of GÉANT2's links operate at 10 Gbps – speeds which equate to transferring over 1,000 digital photos in 1.6 seconds.

With a two-layer infrastructure, based on GÉANT and grid-based middleware, Europe is implementing a world pioneering eInfrastructure that will revolutionise the way in which researchers work. This eInfrastructure is a basic foundation for the European Research Area (ERA). GÉANT2 is also increasingly important in an international context, with interconnections to both developed and developing countries. These include links to North America, the Asia-Pacific region, southern Mediterranean, and Latin America.

The challenge now is to move beyond the current two-layer infrastructure – based on connectivity and data – to add a third knowledge layer equipped with all the tools, facilities and resources necessary for advanced collaborations. This new research environment will give researchers an easy-to-use controlled access to scientific facilities anywhere in the world and will be a one-stop-shop for powerful, all-inclusive services. Research centres and their researchers will be able to work together in virtual research communities, enabling worldwide sustainable partnerships in all eScience fields.

Enabling Grids for eScience

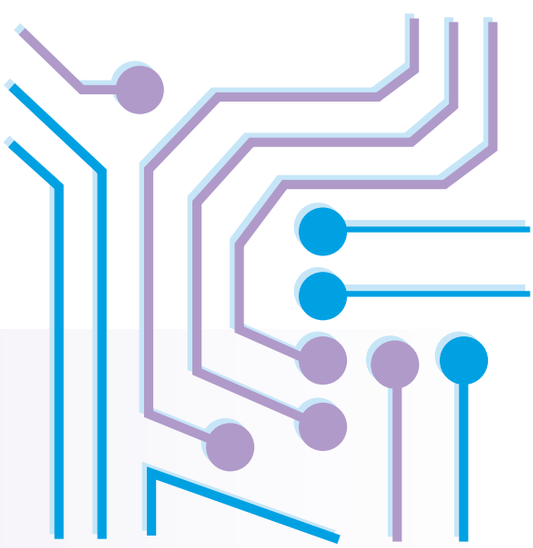
The **EGEE** project aims to provide a production quality Grid infrastructure across the European Research Area and beyond.. It offers a seamless grid infrastructure for eScience that is available to scientists 24 hours-a-day.

From an original focus on two scientific fields, high energy physics and life sciences, EGEE now integrates applications from many other disciplines, ranging from geology to computational chemistry. Generally, the EGEE grid infrastructure is well-suited to any scientific research, especially where the time and resources needed for running the applications are considered impractical when using traditional IT infrastructures.

The EGEE grid consists of over 25,000 CPUs available to users around the clock, in addition to about 5 petabytes (5 million gigabytes) of storage, and maintains 30,000 concurrent jobs on average. Having such resources available changes the way scientific research takes place. The benefits for end-users depend on the users' needs: some value the large storage capacity, while others are attracted by the high bandwidth or the sheer computing power available. The EGEE grid maintains close relations with DEISA, the supercomputer grid project, together addressing an even broader spectrum of computational needs from the scientific community.

EGEE has set up a number of platforms to engage with industry. The Industry Forum helps to raise awareness of the potential of grids in diverse areas of industry and how grid computing can create new industrial solutions. An Industry Task Force brings together representatives from sectors that are already using grid applications, while the EGEE Business Associate programme provides opportunities for companies to engage in technical work in collaboration with EGEE.

In addition, the Commission supports around 15 EGEE-related projects. These aim to extend EGEE to other world regions (and promote peering with other international grids), bring in new user communities, improve technical aspects of the infrastructure, and support policy making (e-IRGSP). **ITHANET**, for instance, is a Euromediterranean network of research centres that is looking to exploit grid-enabled infrastructures and tools in conducting molecular and clinical research. **CYCLOPS** aims to bridge the gap between the grid and civil protection communities, in particular in relation to Europe's Global Monitoring for Environment and Security (GMES) initiative.



> PROJECT DETAILS

GÉANT2
info@dante.org.uk • www.geant2.net

CYCLOPS - Cyber-Infrastructure for Civil Protection Operative Procedures
www.cyclops-project.eu

DEISA - Distributed European Infrastructure for Supercomputing Applications
www.deisa.org

EGEE - Enabling Grids for eScience
projectoffice@eu-egee.org • www.eu-egee.org

ITHANET- eInfrastructure for Thalassaemia Research Network
www.ithanet.eu

> Digital Repositories for eScience

European research in ICT is helping to establish digital repositories of scientific information that will be cornerstones of future scientific advances.

Policy Context

One of the main problems faced by scientists today is that they are drowning in data. As scientific problems become more complicated, and the models and instruments they use to study them become more complex, so the amount of data is increasing rapidly – in some cases at exponential rates. In areas such as radio-astronomy, environmental monitoring, and medicine, new technologies and instrumentation serve as "data factories", able to produce limitless amounts of data that need to be shared by researchers, often at different locations.

This explosion in scientific data creates new challenges in how the data is stored, retrieved, analysed and manipulated. This is not just a problem for the scientists. Given the importance for innovation of research in science and engineering, our ability to find answers to these questions will directly impact Europe's competitiveness.

Hence, access to and the management of scientific information are of growing strategic relevance to Europe's objectives, under the i2010 strategy, to build a Single European Information Space and to reap better returns from Europe's investment in research and innovation. There are complex issues of strategy, policy and practice regarding how such data is created, managed, curated and accessed so as to make it available and valid to generations of future researchers.

A Communication foreseen for late 2006, as part of the i2010 strategy, will set out the specific challenges for digital repositories of scientific and scholarly information, including the role of the supporting infrastructure and the actions to be undertaken at European level. In addition, within FP7 specific funding for this issue has been earmarked under the ICT-based eInfrastructures action line as part of the Research Infrastructures programme.

Building Common Access to Scientific Data Repositories in Europe

Over recent years Europe has invested heavily in eInfrastructure – ICT-based research infrastructure – as tools to support scientific collaborations. High-speed communication networks, distributed storage, and sharing of computational resources and data processing allow scientists to tackle the full scientific process in an innovative and more effective way. The development of eScience in Europe strongly depends on the availability of these pan-European infrastructures.

What is missing, however, is effective ways of sharing and transferring knowledge. We need to move beyond the network and grid layers, which are already deployed, to create a new data layer within the European eInfrastructures. This requires a coherent strategy for developing European digital repositories, federating and providing added value to national and discipline-based efforts.

To build this common access to European scientific results a wide-ranging series of roadmaps are being developed covering technical, legal and organisational areas, national plans, and users. Although focusing on the pan-European infrastructure, these roadmaps also provide valuable information at the national and institutional level.

The majority of content will be provided by the research communities themselves. Institutions (universities and research institutes) throughout Europe should be encouraged to set up institutional repositories and to encourage their researchers and authors to deposit their material. International and subject-specific repositories also need to be integrated in a way which best serves the needs of researchers. Europe also has a rich landscape of national initiatives that will foster broad access to scientific repositories, which could be used as demonstrators and test-beds for future deployment. The adoption of metadata standards should be encouraged at all levels.

Pathfinders for a European Knowledge Infrastructure

A series of demonstrators and test-beds organised under IST projects serve to demonstrate the potential of a European knowledge infrastructure for eScience.

The **DILIGENT** project, for example, is creating a collaboration test-bed for eScience communities. Researchers will use this knowledge infrastructure to manage a network of shared resources (e.g. archives, databases, software tools) and to create digital libraries on-demand. For instance, a virtual research group will be able to dynamically create a digital library that satisfies its needs by specifying a number of requirements on the information space and on the services. This new, cost-effective operational model should broaden the diffusion of digital libraries considerably. The test-bed is being demonstrated in two scientific domains: environmental e-science and cultural heritage.

Also building a test-bed for a future European knowledge infrastructure is **DRIVER**. It aims to demonstrate a large-scale virtual content resource as a gateway to individual repositories. Several user services, including search, data collection, profiling and recommendation, will be implemented in the test-bed. By building a basic scientific content infrastructure and demonstrating its future potential, DRIVER will encourage academic and/or non-academic service providers to build high-value and innovative services on top of it.

One research community that depends heavily on eInfrastructure is astronomy. EURO-VO-DCA is a specifically European implementation of a virtual observatory. It will produce a unified virtual data and service resource (a data and service grid) with the ability to perform complex data discovery and manipulation tasks across the whole range of astronomical research topics. Virtual observatories are transforming the way astronomers approach research, and **EURO-VO-DCA** is part of a worldwide community-based initiative.

Other projects concerned with digital repositories are: **BELIEF**, which is a focal point for debate on research infrastructure communities and initiatives; and **ORIEL**, which has developed tools to navigate and manage the increasingly large collections of scientific data generated in genomics and bio-informatics research.

> PROJECT DETAILS

BELIEF - Bringing Europe's Electronic Infrastructures to Expanding Frontiers
info@beliefproject.org • www.beliefproject.org

DILIGENT - A Digital Library Infrastructure on Grid Enabled Technology
www.diligentproject.org

DRIVER - Digital Repository Infrastructure Vision for European Research
mike@di.uoa.gr • www.driver-repository.eu

EURO-VO-DCA - European Virtual Observatory
lars@eso.org • www.euro-vo.org/pub/

ORIEL - An Online Research Information Environment for the Life Sciences
les.grevell@embo.org • www.oriel.org

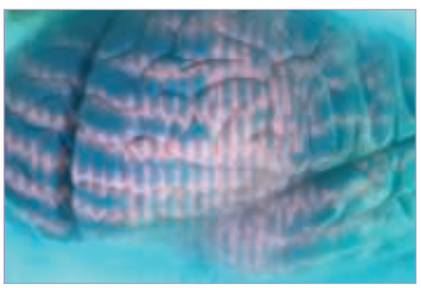
> Building for the Long-Term

Research in Future and Emerging Technologies (FET) helps to set new directions in ICT and lay the foundations for the innovations of tomorrow.

Policy Context

Information and communication technologies (ICT) constitute one of the key forces driving progress in the 21st century. They lie at the heart of a revolution in our economy and society that is transforming the way we live, learn, work and conduct business. ICT is progressively becoming a foundation for improving services to citizens in areas as varied as healthcare, entertainment, government, transportation, environment, and in many other aspects of everyday life. As a consequence of this multidisciplinary environment, the full scope of ICT investigation has broadened considerably, making the identification and fostering of emerging research challenges more complex.

ICT are steadily developing in relatively well-known directions. However, current approaches, for example miniaturisation, will reach 'roadblocks' and further input from science is needed to overcome these limitations. In addition, fundamental breakthroughs and eye-openers are expected to arise from the cross-fertilisation of ICT with areas such as biology, physics, cognitive science, and social science. Longer term advances increasingly rely upon synergies and cross-fertilisation between ICT and many other science and technology (S&T) fields.



Thus, ICT can no longer be seen in isolation, but increasingly as an area which is both enabling and being enabled by others. This accelerated integration of many S&T disciplines will give rise to the next revolutions in medicine, manufacturing, education, energy and many other application fields. At the same time, the widespread diffusion of ICT in society is posing complex organisational, societal, ethical and other challenges that are of ever growing importance, as more aspects of business and personal life come to depend on computers and networks.

In this context, a radical interdisciplinary exploration of new and alternative approaches to future and emerging ICT-related technologies is urgently needed to ensure Europe's long-term competitiveness.

FET: The Pathfinder for ICT Research

IST's Future and Emerging Technologies[1] (FET) action provides this long-term perspective. Its role is to stimulate the emergence and development of new ICT-related disciplines and technologies which promise to have significant scientific, economic and societal impacts. This is achieved through support for visionary, high-risk collaborative research, specifically in areas lacking an agreed roadmap, where options are unclear or ideas speculative.

FET is implemented in two ways: the open domain (FET-Open), which is motivated by the fast-moving and unpredictable nature of change and innovation in ICT; and the proactive scheme, which aims to build up critical mass in particularly promising areas with potential for industrial or societal impact. Research under both approaches is highly interdisciplinary. In this way, FET also supports new emerging research communities in organising themselves, and the coordination of regional or national research programmes.

In FP7, FET will continue to attract and foster interdisciplinary collaborative research excellence in emerging ICT domains and in their combination with other relevant areas and disciplines. Foci include:

- Exploring extreme miniaturisation and new computing and communication frontiers;
- Harnessing the complexity of networked computing and communication systems;
- Exploring new concepts for and experimenting with ever more intelligent systems and for new personalised products and services that are people centric.

[1] See: http://cordis.europa.eu/ist/fet/home.html

Structuring Europe's Quantum Landscape

Europe's scientists in the field of quantum information and quantum technology are amongst the world leading groups. To stay competitive on an international level, common strategies for both funding and research policy are necessary.

The project **ERA-Pilot QIST** aims at structuring the rather young scientific area of quantum information science and technology (QIST) within Europe. Topics covered by this area are, for example, quantum cryptography, quantum teleportation, quantum computers and their applications.

The project is part of the EU's ERA-NET scheme which provides support for the transnational networking and coordination of national research programmes (see page 6). It will develop an inventory of European activities and centres of excellence as well as guidelines to inform strategic decisions and a common vision for the future of QIST in Europe. The European QIST roadmap will help researchers and industry to achieve the leading position in QIST globally.

Looking Beyond the Horizon

Beyond-The-Horizon was an FET coordination action that provided input about emerging trends and strategic research in IST-related areas. It undertook an extensive and systematic consultation of the relevant research community throughout Europe, involving the main actors and experts in the related fields. Having identified advanced strategic areas, the project analysed their scientific, societal, and industrial impact and worked with the research community to deliver roadmaps for paving advances in these areas within a fifteen year timeframe. It also investigated new frontiers for ICT research, identifying the boundaries with other disciplines, as well as interrelationships among them and opportunities for cross-fertilisation.

From a wider science policy perspective, FET projects contribute to science and research policies through technology and research roadmaps and vision papers being developed by FET research constituencies. Examples include the coordination actions in areas such as neuro-IT, robotics and complex systems.

> PROJECT DETAILS

Beyond The Horizon - Anticipating Future and Emerging Information Society Technologies
dp@ics.forth.gr • www.beyond-the-horizon.net

QIST Europe - Structuring the European Research Area within Quantum Information Science and Technology.
christian.monyk@arcs.ac.at • www.qist-europe.net