Development must follow research

Exclusive foreword by Maria Khorsand, CEO, SP Technical Research Institute of Sweden

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Christian Kjaer, EWEA

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It might seem to be a paradoxical situation. However, the demand for research and new knowledge is enormous at a time when the volume of existing knowledge and its growth rate have never been greater. Despite all the developments achieved by the modern world, our basic needs remain the same: to maintain health, to procure enough food of an adequate quality, to secure a place to live, to be able to travel, to trade, and to communicate. The demands are however much greater and much more complex than they were a century ago. The possibilities are also, due to the scientific evolution achieved in the same period, much greater. Many examples of this can be given:

- Functional and healthy food, efficient use of fertilizers and transportation
- Construction and infrastructure which uses and re-uses geological materials and polymers in a sustainable way
- Energy efficient housing via the use of heat pumps, bio fuels, district heating, insulation that minimises heating requirements without indoor environments being destroyed by volatile organic components from polymer products
- Logistics and technology for new generations of electric vehicles which primarily use solar energy, solar cells and batteries and incorporate new types of safety issues
- The ever increasing importance of security in IT and communication systems and the ever more critical nature of this security

There are however also completely new conditions that we have not experienced before. Energy has become a sparse resource and drastic changes have to be made within technology to ensure enough energy is produced, stored and distributed in a sustainable way. Globalisation forms a melting pot in which the world’s different cultures meet and intermix. This can provide the world with opportunities in the form of trade and efficient production. But, globalisation also presents us with problems such as the safety of food and security in electronic communication.

As a result of the above, there is an urgent need to shorten the time from scientific break-through to commercial production and the associated societal improvements and to achieve more efficient resource employment in research, without this compromising the integrity of scientists in their search for new knowledge. Many highly important areas also require borders between disciplines to be opened, as broad, cross-technology approaches are required to allow the fusing and creation of new disciplines, as seen in for example bio-informatics in recent decades.

My background as a leader of large product development projects in the telecom industry has made the move to becoming the new CEO of a national research institute and seeing its inherent potential for innovation a revelation. Broad technologies meeting demands from multi-disciplinary fields such as energy or construction, working from research to product development and international and national co-operation with universities all are USPs for an institute when it comes to contributing to excellence in innovation. Universities with strong integrity and a strong scientific basis and research institutes which are open minded to external input and that take part in industrial development, make particularly ideal partners for co-production with industry, such as in European projects. The different perspectives of industrial development, university scientific development and technological development at institutes generates cross fertilisation. A culture of recognising and joining forces in a wide spectrum of research types is a prerequisite. Focused research projects as well as those driven by curiosity are vital. They both encapsulate a range of research approaches, from those built on the creation of ideas, to those where ideas are used to establish new products or processes.

The European framework programmes have been an important and vital part of the European innovation system. Although the framework programmes have achieved improvements, there still are problems which act as obstacles to the work of many researchers and which prevent efficiency. The success rate in applications is very low. This has initiated a new industry of consultants who supply successful proposal writing services. This does in fact risk becoming more important than content! Formal project requirements and the size of projects furthermore mean that the proportion of resources used on research and the exploitation of results becomes too low. Changing this is an important task for European research in the coming years not least to increase the technology content in SME products.

One thrilling initiative is the EIT concept, not least because of the inherent opportunity to apply a longer perspective. It is believed that this is even more important than size in the creation of strong research environments. Very large groups can become bureaucratic and static. Many of the centres of excellence that create Nobel prize winning work are not characterised by their size, but by their long traditions of building and attracting excellence and by their open mindedness to the industrial world outside the academy.

So, the challenges of the future are more demanding than ever before. The opportunities for solutions are however greater than before. Through cross border cooperation, we can achieve the rapid technical development and the technical breakthroughs required to achieve the sustainable society of the future. Together industry, universities and research institutes supported by a future orientated and insightful innovation policy, make ideas work for a better future life.

Maria Khorsand is the CEO of Sweden’s largest research institute, SP Technical Research Institute of Sweden and an Executive Board Member of EARTO.
foreword
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World changing scientific research needs dissemination
It's obvious when comprehending events like ICT 2008 in Lyon, France, that Europe celebrates and drives innovation and technology to a level that is envied by the rest of the world. The targets that Europe's task masters intend to hit in the following years are ambitious and revolve around a society that is built on the principal of using knowledge as economic fuel. This alone shows that Europe has in mind a revolutionary system that we can all benefit from, a system that embraces technology for all.

Research is the central focus for this knowledge-driven economy, which is creating wealth and employment in Europe. Research also underpins much of the services our public bodies provide the citizen. An informed understanding of this research is essential for those seeking to provide that service and that is something our magazines offer the reader as we reflect much of the good work being done as well as question the things that need to be questioned.

And so we must ask ourselves, ‘where could Europe do better?’ ‘How could Europe achieve its goals more efficiently and more effectively? Talking with the Minister of Information Society of Macedonia recently, the results of which can be read in our current issue of eStrategies Europe, it occurred to me that countries such as Macedonia move with a dexterity that evades many larger, richer countries in the EU. Macedonia, as with many smaller or developing countries, can define their structure easily, without too much legacy to untangle, experiment with new country-wide initiatives without battling bureaucrats, eurocrats and red tape from those that in reality should be smoothing the path. Countries like this have a youthful national energy to them, as if they are hungry to move at a fast, light-footed pace, embrace wholesale new ideas, and take advantage of the technologies that are now available to them as a way to enable their citizens to better themselves and enjoy a richer existence.

Of course countries like Macedonia will never deny the fact that they have learnt much from their more advanced neighbours and copy many of the systems that have already been put in place elsewhere. Indeed, such is their honesty that they would freely admit to this technological mimicry as it enables them to bypass many of the problems and achieve the results far quicker.

So many countries would do well to observe what they are doing and observe very carefully, as they will accelerate into the future in a remarkable way.

Let’s hope that they don’t lose any of this zeal when having to deal with the bureaucratic obstacles and legacy many more developed nations have to deal with.

Lastly, for all those of you who are attending ICT 2008 in Lyon, I hope you enjoy what promises to be an astounding event and you make the most of this unique gathering of Europe’s finest minds.

British Publishers will be there in force. See you all there! Please come and talk to us.

Let’s hope that they don’t lose any of this zeal when having to deal with the bureaucratic obstacles and legacy many more developed nations have to deal with.
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The wind energy market is booming, and Europe is the global leader. Between 2000 and 2007, wind energy was the second largest contributor (30 per cent) to new power capacity additions after natural gas (55 per cent), with its total installed capacity leaping from 13 GW to 57 GW.

Due in part to this growth, there is a belief that no more research and development (R&D) is needed for the sector. However, there are several reasons why such a belief is mistaken.

In 2007, 43 per cent of new installations worldwide occurred in the EU-27, and six out of the top 10 manufacturers were European. Yet domestic manufacturers from third countries such as the US, China and India are inching further onto the global platform. Should this continue, Europe could risk losing its position of leadership and its potential for exports worldwide.

For decades, conventional forms of energy and nuclear power have received vastly superior levels of research funding to renewables and this is still the case, even though they have had far longer to mature. Between 1974 and 2002, nuclear energy received 58 per cent of energy research funding in the IEA countries, and fossil fuels 13 per cent, while wind energy got 1 per cent.

Over the next five years, nuclear energy will get 54 per cent of the average annual EU research budget, compared to renewables and energy efficiency at 23 per cent. Successful R&D would reduce wind energy costs, making it even more competitive than it already is compared with tradition forms of power supply.

Finally, ambitious EU renewables targets – 20 per cent of energy from renewable sources by 2020 – require wind energy to expand even more quickly. In 2007, 8.5 GW of capacity was installed in Europe. This must increase to an average of 9.5 GW per year up to 2020 in order to meet wind’s expected contribution to the EU targets and the European Commission’s ambition of 12 per cent of EU power demand coming from wind energy in 2020.

A competitive, knowledge-based economy

An increase in wind energy research funding would help the sector contribute to the Lisbon Agenda, increasing European knowledge, dynamism and the economy. The ‘Barcelona objective’ agreed at the European Council in 2002 states that investment in research and technological development must go up to 3 per cent of GDP by 2010, from 1.84 per cent in 2006. If this objective were met, R&D investment in wind energy would represent an average of 430 million Euros per year.

Even though there is a long way to go, and the 2020 target is looming ever closer, there are already significant signs of progress. In 2007, the EU’s Strategic Energy Technology Plan set a new agenda for energy research and innovation, with the aim of speeding up the deployment of low-carbon energy technologies. One of the proposed key areas of action is industrial initiatives, including a European Wind Initiative, which should be a major part of European research and innovation in wind energy technology. This should help bring about reduced costs – with wind energy becoming the most competitive energy source on the market – large-scale deployment and Grid
An increase in wind energy research funding would help the sector contribute to the Lisbon Agenda, increasing European knowledge, dynamism and the economy

integration for both onshore and offshore wind power, stable support mechanisms, better human resources for the sector and long-term EU leadership.

Research priorities
There are certain areas of wind technology which are at the top of the list in terms of research priorities. Notably, there is a need for a better (within 3 per cent accuracy) prior knowledge of the expected energy production for any terrain and of offshore conditions.

Other priorities relate to the electricity grid – higher wind penetration and improved grid management levels must be achieved. The infrastructure needs updating in order to incorporate large amounts of wind energy, and competition in the electricity market must be dramatically improved, for example through full ownership unbundling of production and transmission activities to create a level playing-field.

For offshore wind – a resource whose enormous potential has hardly begun to be tapped – there are various areas needing research, from the transporting of the equipment to the site to substructures, larger turbines and a greater knowledge of the offshore environment. Moreover, the Environmental Impact Assessments carried out before a wind farm site is selected could be made more efficient, as could the administrative procedures for obtaining authorisation to build.

Research priorities
If Europe wants to maintain its global leadership and be sure of meeting its binding renewables targets, it must be willing to help researchers explore ways of optimising and perfecting every part of the industry. A strong and clear signal from the European institutions, showing their support for renewables and for wind in particular, would act as a catalyst at Member State level, as well as stimulating the private sector to get more involved.

The real problem that Europe faces is not a lack of technical solutions but a lack of time. 2020 is just around the corner. The longer it takes to adapt the EU energy system – in terms of policy, infrastructure, technology and markets – to wind energy, the more difficult and costly it will be. This will have an unknowable impact on the environment, on Europe’s dependence on third country fuel imports, and on our energy future.
Snapshots of the amazing world of GRID

In Geneva, Switzerland, Freya Blekman arrives at work in her favourite band’s T-shirt. She sits down at her computer and starts looking for the Higgs Boson. Blekman is an experimenter with one of the Large Hadron Collider experiments—the next-generation particle accelerator just started-up at Europe’s centre for particle research, CERN.

In a different time zone and different hemisphere, Ibrahima Niang, head of the Dakar Computing Centre at Dakar’s university, Université Cheikh Anta Diop, Senegal, sits down to his computer, logs in, types a command and connects. He manages a centre which allows him, and other scientists to stay within their native country, fighting ‘brain drain.’

Though they are 4,000 kilometres apart Blekman and the researchers in Senegal are in fact colleagues – contributing to Large Hadron Collider experiments.

Sandwiched geographically between these two is Paolo Fiorucci, a member of the International Centre on Environmental Monitoring, or CIMA. This foundation runs models that predict forest fire and flash flood risk. The Italian Civil Protection Service uses these models to advise local authorities when risky conditions exist in their area. Local authorities may then decide to send fire-fighting aircraft or crew to critical areas so they can respond more quickly if a fire breaks out.

Fiorucci has spent the past 10 years developing a fire prediction system, known as RISCO, and is currently testing its use on the ‘Grid’. He hopes it will be used, full-fledged on the Grid in the next two years.

“This will bring many advantages,” says Fiorucci. “It will let us run predictions at a much higher resolution of space and time. We’ll be able to run different kinds of models as well, not only the one we currently use. We’ll be able to introduce changing factors such as land use and vegetation cover. Also we’ll be able to include a fire propagation model which gives predictions for several scenarios.”

Since these require much higher CPU hours, it will only be possible with the Grid. We will get our results more quickly and they will be more accurate. I think in the future Grid will be important not only in fire prediction but in many areas of natural risk, such as floods and land-slides.”

These three researchers have several points of connection. They all use the same technology in their work: Grid computing. They are further connected in that they use Grid is changing the world. Danielle Venton at CERN, the European Organisation for Nuclear Research – who are deeply involved in using Grid, is in the perfect position to explain why and how Grid can accelerate research and revolutionise science as we know it.
the same computing infrastructure and this infrastructure allows their computers to connect and share thinking power.

What is a Grid?
Working through Internet connections, Grid computing makes it possible to share computing power and storage. The ‘grid’ analogy is based on electrical power grid. Just as energy consumers can plug in to the electrical grid to access as much electricity as they require, without thinking about who is providing it or how it is produced, so one day consumers in need of processing power may be able to plug in to a computing grid to get all the power they need.

Grids require computers, network connections, jobs to be run and people willing to cooperate, but none of this would work if it wasn’t for a crucial piece of programming: the middleware. Middleware interlinks separate Grid resources into a seamless whole. Conceptually it sits ‘in the middle’ between operating systems software (like Windows or Linux) and applications software (like a weather forecasting programme).

The potential of Grids is essentially unlimited. One day Grid computing may allow the global network of computers to become one vast computing resource. The reality is hardly less exciting. This technology makes new science possible.

With access to more computing power than ever before, scientists use Grids to study questions like:

\begin{itemize}
  \item What happened in the first moments of the Universe?
  \item How will global warming change our Earth?
  \item What new drugs could fight cancer or malaria?
\end{itemize}

Access to more computing power allows researchers to conduct studies that would not otherwise be feasible due to a limited IT budget or time constraints – a reality for most, if not all, researchers. For example the driving force behind Grids (the data needs of the Large Hadron Collider) gave rise to Grid computing for just this reason. LHC planners realised in the late 90s that a maximum of 10 per cent of the total LHC needs could be installed at CERN (see image on right). So clearly they had to look elsewhere. An elegant solution was proposed to distribute the load: a global grid of computers that would share storage
and processing power. This required a major technological leap and the age of Grid computing was born.

Now that the LHC is preparing to begin collisions, this global collaboration – called the Worldwide LHC Computing Grid – has become a reality. It stands ready to catch mammoth loads of data per year, which the LHC will hurl at it.

The Worldwide LHC Computing Grid and Enabling Grids for E-sciencE

CERN is leading the international project Enabling Grids for E-sciencE, co-funded by the European Commission. Grid software developed by EGEE is used for the LHC Computing Grid but its Grid infrastructure extends beyond particle physics, to fields such as biomedical and geophysical applications. EGEE is building a permanent European Grid Infrastructure so that the benefits of Grids are available to researchers in all disciplines for many years to come.

The basis for this infrastructure is in place. In mid 2008, some 9000 scientists and engineers from five different continents are working on EGEE. They have created a Grid of 80,000 CPUs from 300 sites around the world. Between September 2007 and September 2008, 80 million jobs were successfully run on this Grid! But the real fun is just about to begin.

The LHC will produce an expected 15 million gigabytes of data every year, enough information to create a 21-kilometre-high stack of CDs annually – over 20,000 years of listening time! Remarkably this collider will generate not only more data than any one experiment has ever generated, but more data than all high energy physics experiments together have ever generated. The LHC Computing Grid, of which EGEE is a fundamental part, will capture and organise this data, sending it all around the world to be analysed at 140 computing centres, organised in to a ‘Tier’ system. Thousands of scientists across the planet will be clamouring for access to the streams of data that will come out of the instrument.

Eager to get their hands on the data

“My use of the Grid is about to become much more intense,” says Freya Blekman, Cornell Post Doc, CERN, CMS.

“I’ve used it for testing and calibration with simulated data, but that becomes dull. We’re experimental physicists – we’re very excited to see real data and the Grid is our only way to get to it.”

The benefits of the Grid are not limited to physics researchers like Blekman. Indeed, any researcher who works with massive amounts of data can benefit.

Fighting malaria with the Grid

The WISDOM project, a collaboration between eight core institutions in five countries, began searching for anti-malaria drugs in 2005. Rather than go straight to the lab, the team used a Grid-powered software program to screen for potential drug-leads, searching for small molecules – called ligands – that could bind to and disable the malaria protein plasmepsin.

The search for this perfectly matched ligand led the WISDOM team to perform 41 million ‘dockings,’ screening a million molecules and then discarding all but the 30 most promising molecules. These 30 ligands have now advanced to the next stage: in vivo testing in living cultures of the malaria parasite.

Classical pharmaceutical research often requires 15 years for a drug to be developed and approved. Thanks to Grid-power, the WISDOM team have accelerated this process and are in the lab after just three years of research. They are expanding the same approach to diabetes and avian flu research.

Customers welcome: Geocluster open for business

During summer CGGVeritas, the first business to develop an industrial application with Enabling Grids for E-sciencE, opened its doors to clients. “Everything is set for our sales team,” says Gaël Youinou, Software Department Manager at CGGVeritas. “I expect that the first contracts with clients will be signed before the end of the year.”

The company deploys a software that processes seismic data – feedback from compression waves. The software, known as Geocluster, creates three dimensional underground maps which outline properties of the subsurface and the locations of oil and gas reserves. A sister application - Reservoir Simulation - models how the fuel reserves will evolve throughout the drilling process, enabling more efficient extraction. The data is then interpreted by a geophysicist who then directs their company where to drill.

These applications were developed to operate in a Grid environment, using gLite, by the virtual organisation EGEODE. EGEODE used EGEE’s infrastructure as a research environment and tested. Members of the VO come both from the business sector, such as Youinou, and academic laboratories.

CGGVeritas will sell the application software as a package or a service. Since the EGEE infrastructure cannot be used to
operate businesses, CGGVeritas have developed their own. Their service is offered via a web portal.

“This is a huge benefit to the client,” says Youinou. “Beyond the ability to process data quicker, without managing new IT hardware and software, he can access data wherever and whenever and can easily collaborate with distant colleagues. In the end, their business will be more flexible and they will be able to reach the market more quickly.”

**Using immense computing power for image searches**

A small company called Imense, is tackling the problem of the growing backlog of unannotated and unsearchable images on the Internet. Their solution is conceptually simple: a technology able to recognise a wide range of visual categories, such as grass, sky, sunset or beach, as well as to spot and interpret faces. This technology allows a user to search for images with specific visual content, just by entering a plain text query.

The computer power required to execute such a solution is immense. By adopting EGEE’s open source gLite middleware to run their content-based image retrieval technology, this work is feasible.

“Our work with the Grid let us demonstrate that our software can handle millions of images, at a time when we were a small company and could not supply the computing power needed ourselves,” says David Sinclair, one of the founders of Imense. This impressed his investors, and led to funding for the company.

The GEOSCOPE program, which also runs on EGEE, is the French component and founder of a worldwide network of seismic monitors. This network takes part in the locating and studying of earthquakes and seismic activity across the whole planet.

A relatively new area of research, which has come into its own in the past five years, is the study of ‘seismic noise’. Even when there are no seismic events, the earth vibrates gently – similar to the ambient noise of a quiet street. This noise is influenced by things like human activities, the weather and the changing of tides.

GEOSCOPE researchers like to study seismic noise not only because it is useful in testing the sensitivity of their instruments, but understanding it can be a path to studying other low-level seismic signals: subduction zones, ice-quakes and the connection, or ‘coupling,’ between the Earth and the atmosphere. Beyond being interesting for its own sake, these investigations may shed light on how climate change is affecting our planet. Standards are key to interoperability. While some researchers dream of a day when all computers will have Grid connections, resulting in an all-pervasive global Grid, the reality is that instead of a single Grid, there are many smaller Grids, each customised to the specific needs of a user group. These different needs have led to different technical solutions: Grid solutions developed for one Grid don’t always work for another.

**Benefits of Grid**

- Multiple copies of data can be kept in different sites, ensuring access for all scientists involved, independent of geographical location.
- Allows optimum use of spare capacity for multiple computer centres, making it more efficient.
- Having computer centres in multiple time zones eases round-the-clock monitoring and the availability of expert support.
- No single points of failure.
- The cost of maintenance and upgrades is distributed, since individual institutes fund local computing resources and retain responsibility for these, while still contributing to the global goal.
- Independently managed resources have encouraged novel approaches to computing and analysis.
- So-called ‘brain drain’, where researchers are forced to leave their country to access resources, is reduced when resources are available from their desktop.
- The system can be easily reconfigured to face new challenges, making it able to dynamically evolve throughout the life of the LHC, growing in capacity to meet the rising demands as more data is collected each year.
- Provides considerable flexibility in deciding how and where to provide future computing resources.
- Allows community to take advantage of new technologies that may appear and that offer improved usability, cost effectiveness or energy efficiency.

In the Grid world, the Open Grid Forum is the largest group working towards standards adoption. The OGF provides a global opportunity for volunteers from all walks of Grid computing life to contribute to developing new standards. The process sounds simple: first, a group works to develop best practices in a particular area, then, the group approaches OGF for endorsement of that work as a particular standard. Or, in reverse, an area of interest is first identified, and then a group is formed to work on a standards solution in that area. These processes may sound simple, but in practice, the path to achieving an accepted, implemented standard is long and dotted with potholes. Another barrier to wider Grid adoption is the technical complexity associated with using it. Simpler interfaces and more automated processes would lower the barrier of entry for new users and new resource providers.

The potential of Grid computing is ever expanding. As the technology stabilises, through improved international standards and reliability, Grids are gaining acceptance in mainstream business and science communities. Grids are fast becoming an integral part of research and industry.

In many business sectors cloud computing is picking up momentum as the next ‘big thing.’ Many of the ideas and paradigms first developed in Grid computing are being used in cloud computing. EGEE is helping bring the two technologies together.

The EGEE infrastructure has become mission-critical for many research communities. To safeguard this tool they use in their daily work, the infrastructure is currently moving towards a sustainable service. This is similar to the Internet infrastructure or energy grid: universally accessible, but with local and national management of resources, where individual countries and institutions are responsible for their own contributions to the global whole. The European Grid Initiative Design Study is already underway to create a blueprint for this next stage.

Thanks to Alex Efimov and the GridTalk project for their help in preparing this article.
The communities of Germany's D-Grid

**The German Grid Initiative (D-Grid)** aims on achieving sustainability by incorporating a broad spectrum of different communities. The origins of these communities are in both academia and industry. It is the goal of D-Grid to explore synergies between the approaches of these communities so that communities can benefit from each other without giving up their own identity. Further, various service and integration projects assure that the same basic components and services are available to all communities. Finally, the German Federal Ministry of Education and Research (BMBF) did not only fund all the community projects but also provided investments to generate an initial Grid infrastructure located at many centres throughout the republic. In this article, we present some of the 22 D-Grid projects that are presently active.

**DGI-2 at the core**
The D-Grid Integration Project 2 (DGI-2) forms the core of the D-Grid base. It has the goal to put the German Grid infrastructure on a sustainable basis for long-term use.

The contents and the structure of DGI-2 are mainly community driven. This has led to five important focal points of DGI-2: Support and operation of the core Grid infrastructure, security, data management and sustainable business models. Although DGI-2, like DGI-1, is not a development project but a consolidation project, some specific development measures are indispensable and also form a work package of DGI-2.

From 2005 to 2007 the precursor DGI-1 has created a sizable core Grid infrastructure in Germany that is used by about 20 community projects today. This also the configuration effort will be minimised to the absolutely necessary topics supporting the standardisation of middleware installation and enhancing the general Grid productivity.

Finally, the main aspects for the sustainability of the German Grid infrastructure will be investigated. Many organisational and legal questions will be addressed prior to the execution of workflows across institutional or state boundaries. Legal aspects covering software license conditions will be investigated enabling service providers to offer a wide spectrum of Grid services in Germany. Likewise, economic aspects such as profitability and standardisation are being taken into account. New insights will lead to case studies showing potential new service providers opportunities on how to offer their services in an easy and economic way.

**Dissemination**
The project Sustainable Grid Infrastructures (SuGI) complements the work of DGI by disseminating the knowledge of Grid technology and thus enhancing its use. Therefore, SuGI addresses all academic computing centres as well as enterprises, which still have not adopted Grid technology. It makes the research experiences gained in the D-Grid projects available to the public. To this end, SuGI offers training courses, supports courses given by other projects, creates video and audio recordings and provides them online to all D-Grid communities.

In addition to the dissemination of the necessary Grid know-how, SuGI also works on the applicability of the used Grid middleware by simplifying the installation and maintenance tasks. Not only standard middleware installations are affected, but also the configuration effort will be minimised to the absolutely necessary topics supporting the standardisation of middleware installation and enhancing the general Grid productivity.

**Climate research into the Grid**
The Collaborative Climate Community Data and Processing Grid project (C3Grid) represents one of the academic research communities. In climate research, there is a growing focus on the evaluation of multi-model ensemble simulations, which at the same time comprise of data with...
higher spatial and temporal resolution, meaning strongly growing amounts of data. Before a regular user can process these data, he must identify the location of their storage systems as well as the formal and logical data formats. In most cases, processing of the data cannot be done at the storage system itself, so that transfer of the data to a suitable processing location is necessary. These steps are part of the regular workflow of data analysis which is time consuming and hampers the scientific process. The C3Grid project has been formed to address this problem.

The software services of C3Grid permit an identification of datasets and uniform data access, irrespective of the individual location. A Data Information Service collects the metadata of all data resources and provides miscellaneous search features for users. Furthermore, C3Grid offers tools to extract and process data. Up to now, some prototypical workflows for analysis of meteorological data are already implemented. In addition to these standard workflows a wide range of individual workflows can be included consisting of data extraction, data transfer and execution of some kind of calculation jobs. The user can submit these workflows at the portal. The underlying middleware of C3Grid, including Workflow Scheduling and Data Management Services, takes care of the distribution of tasks within the Grid infrastructure, thereby optimising the allocation of computing and data extraction resources as well as the automatic handling of intermediary data transfers. The implementation of different C3Grid services is based on the Globus Toolkit 4.0.x Framework. This ensures compliance to widely used standards in service definition and communication and provides a basis for interoperability to other Grids, e.g. the NERC DataGrid.

As an example, the analysis of the integrated transport of humidity between selected levels in the atmosphere is presented here. Based on a simulation the integrated transport of humidity in Africa was analysed in C3Grid. In the figure above, the flow directions indicate the moisture period at west Africa in summer due to monsoon (left) as well as the dry period upcountry in winter (right).

Grid for the arts and humanities

TextGrid is the first project in the arts and humanities in Germany creating an academic research community Grid for collaborative editing, annotating, analysing, and publishing of specialist text resources. Providing a computational infrastructure, a collective network, and a comprehensive generic toolset for specialists in the arts and humanities, it is based on e-Science methods and forms a cornerstone in the emerging e-Humanities. The project establishes an interdisciplinary platform, a virtual workbench for research and a trustworthy repository for research data. The resulting architecture is shown in Figure 2.

Open interfaces open the door for other projects to plug into TextGrid. Thus, any arts-and-humanities specialist can adopt TextGrid for his work. In its core functionality, however, TextGrid is, at this stage, focused on text as a data type since there is considerable demand in the community for processing text data.

In spite of modern information technology and a clear thrust towards collaboration, researchers in the arts and humanities cannot currently make full use of the potentials of this development. For example, text scholars researching into the relations between language and discourse and into the complex processes in the genesis of literature, still mostly work in local systems and project-oriented applications. Current research initiatives also lack integration with already existing text corpora, and they remain unconnected to resources such as dictionaries, lexica, secondary literature and text processing tools. This integration and interconnection, though, bears a wealth of opportunities. With its architecture and integrated tools and services that satisfy these requirements, TextGrid is able to provide such forms of integration.

To ensure technological compatibility and data interoperability and to quickly respond to new requirements arising in
the arts and humanities, TextGrid participates in several international projects concerning the e-Humanities (DARIAH, interedition, Bamboo) and Grid technologies as well as standardisation issues (Open Grid Forum, IEEE – Repositories Track).

**Grid means good business**

The project Business Information Systems in Grids (BIS-Grid) focuses on employing Grid technologies for information system integration. It has the goal to enable small and medium enterprises (SMEs) to integrate heterogeneous business information systems and to use external Grid resources with the least possible additional effort. To this end, BIS-Grid especially considers industrial security requirements on Grid utilisation and integration as a Service distribution model. It particularly develops Grid workflow middleware that is capable to orchestrate WSRF Grid Services. This middleware is based upon service extensions to the UNICORE 6 Grid middleware using an arbitrary WS-BPEL workflow engine without modification. This integrates the WS-BPEL language, the industry de-facto standard for service orchestration, into Grid technology. As the exchangeability of the WS-BPEL engine in the BIS-Grid middleware is guaranteed this approach avoids incompatibility with commercial WS-BPEL engines.

The BIS-Grid middleware enables enterprises to dynamically switch between enterprise-specific Grid-based EAI and Grid utilisation. While in the first case resources and applications are both located within an enterprise (inhouse providing), it is also possible to outsource application providing and/or resources (Grid application providing), and even the integration of self generated services into the Grid while guaranteeing appropriate quality of service requirements. This allows the use of external Grid Services in enterprise-specific workflows, and helps to create specific Virtual Organisations (VOs) that may traverse enterprise boundaries within a defined range.

**Geospatial data and the Grid**

Vast amounts of geospatial data have been gathered in the last decades. With the advent of commodity applications such as Google Earth, usage of these geospatial data has become ubiquitous. However, most raw data must be processed before it can be put into a meaningful context. In the Spatial Data Infrastructure Grid project (GDI-Grid), computationally demanding tasks such as disaster and noise dispersion simulation will be deployed on existing Grid resources to dramatically decrease computation times. GDI-Grid plans to combine two complementary technologies: the well-established Spatial Data Infrastructures (SDI), which mainly provide access to spatial data resources, and the Grid, which performs processing and storage of enormous amounts of data. From a technical point of view, it is necessary to develop interfaces between the current base technologies of SDI and the Grid middleware to enable seamless processing of spatial data in Grids. In order to achieve this goal, data and models must be coupled with Grid services and security mechanisms to create and enable entire SDI-specific workflows in Grid environments.

In GDI-Grid, industry-leading partners team up with academic research in an effort to leverage the advantages of Grid technology and spatial data infrastructures. Combining cutting edge technologies from both disciplines leads to a significant improvement of disaster simulation and...
recovery. Special attention is given to the detailed simulation of flood catastrophes – an important scenario considering the very current discussion about global climate change.

Better use of renewable energy

In general, the generation of usable energy increasingly depends on renewable energy sources whose availability varies significantly over time and space. Nevertheless, it is highly desirable to plan the deployment of new solar and wind power plants based on reliable data and to operate the existing facilities efficiently. Moreover, energy distributors need economically competitive energy generation capacities based on the renewable energy sources. These tasks require very detailed information about the available solar and wind power plants' optimisations to the estimated supply and the resulting energy production. Very large data sets, near-realtime computations with physical models such as numerical weather prediction models, and simulations of solar and wind power plants' optimisations to the estimated supply are direct consequences of these needs. As a result, energy meteorology is not just interdisciplinary, but also a highly compute-intensive area of research.

The Knowledge Network Energy Meteorology project (WISENT) pursues as its main objective the construction of a high-performance IT infrastructure for the young energy meteorology community. Grid technology enables efficient numerical simulation and the processing of large amounts of data; thus, allows the improvement of prediction methods and other applications for energy meteorology such as determining optimal locations for different types of power plants. For example, archived solar irradiation data combined with geographical information and technical-economical information can be used to select sites for solar power plants. Such simulations and analytical computations are based on heterogeneous data sets from various sources such as satellites and meteorological ground stations. The large amount of data and the complex computations cause unacceptably large processing times on a single computer. In addition, newer generations of satellites will deliver higher resolution images, which will further increase the data volume. As a consequence, new solutions for looking up data stored in the Grid are required. Grid technology promises an efficient solution for the processing of such large amounts of data and for executing complex simulations. With this technology, the WISENT will be capable to contribute to the securing of tomorrow's energy generation based on renewable energy sources.

Grid helps collaboration

Industrial design and production processes are increasingly based on the division of labour. Companies concentrate on their core competences and buy parts, equipment and services from third parties, instead of covering the full value chain. To support this trend, the PartnerGrid project develops a collaboration platform based on the D-Grid infrastructure and D-Grid services that facilitate the co-operation of companies with a special focus on small and medium enterprises (SME). The functionality and the benefits of this collaboration platform are demonstrated by using it on two typical scenarios of different industrial areas:

In the founding industry, rising quality requirements and demand of very short development processes generate high competitive pressures. To meet these challenges, a close collaboration between the foundry and its customers as well as efficient optimisation processes of cast parts design based on cast-technical simulations are needed. PartnerGrid develops a Grid-based virtualisation strategy with special focus on licensing issues. The implementation of this strategy enables foundries and their customers to efficiently use all available resources resulting in a better design and an optimisation of their casting processes.

Virtualisation technologies are also used to carry out crash- and plastic deformation simulations in today's metal-processing industry. This requires a fast and secure data management infrastructure and collaboration support for tasks like project management, result presentation and expert discussions. The PartnerGrid consortium develops a Grid-enabled collaboration platform that integrates these simulation runs with the associated project management tasks.
Industry into the Grid
The Biz2Grid project aims to migrate industrial business applications to existing Grid middleware systems. To this end, it is necessary to design the organisational structure and an economically reasonable billing and pricing approach for Grid resources in combination with a prototype implementation in commercial example settings.

At the associate automotive partner BMW Group, two applications are selected for this purpose. Besides the pure technical implementation the project wants to determine how the existing IT structures in planning, procurement and maintenance can dynamically be affected by market mechanisms while maintaining a stable control and business environment. On the one hand Biz2Grid contributes to commercial use of Grid applications. On the other hand resulting services can be used for D-Grid as well as for developing commercial products with proprietary components.

AeroGrid project flying high
The AeroGrid project also addresses users from the German mechanical industries and corresponding research centres. It plans to provide an efficient Grid based working environment for the aerospace research community. The AeroGrid environment will be a permanent and effective Grid infrastructure for cooperation between industry, research centres, and universities in aerospace engineering and research. The environment allows virtual organisations to cooperate in research and development projects, to always use up-to-date program versions, data, and compute resources across all locations, and to document and trace the detailed history of a computational process that leads to a certain result.

The design of the AeroGrid environment addresses two important requirements: First, suitability for daily use, especially for the productive operation by service providers after the end of the project and second, applicability to similarly organised communities in science and industry. The integration of a Provenance service which records detailed information of all conducted execution steps, increases the dependability of the results and improves the user's confidence in their quality. The AeroGrid environment will consist of two different user interfaces, a Web portal based on GridSphere and VINE, and the data management client application DataFinder. Both user interfaces will be customised to support the various usage scenarios. The Grid middleware used for the AeroGrid infrastructure is UNICORE 6, but the user interfaces allow the usage of Grids based on the Globus Toolkit too.

Banking on Grid
Increasing competition in the German banking sector is similarly leading to a high pressure for restructuring and further automation in IT-related business processes in banks and financial services providers. Additionally, new legal regulations such as Basel II and changing customer needs towards highly customised on-demand financial products enhance this pressure. To address these challenges, the Financial Business Grid (FinGrid) project strives to identify suitable services and processes in the financial services sector and to develop Grid-based systems that enable financial service providers to reorganise their processes efficiently and to realise applications that have been impossible so far in terms of computational requirements.

To guarantee relevance for the target industry, the research is performed jointly with leading financial industry partners. Based on the technical foundations of D-Grid, new prototypes for banking service provisioning together with integrated pricing and accounting structures are being developed, tested, and implemented within the financial services sector. These prototypes are developed in cooperation with Deutsche Bank, Dresdner Bank, IBM, and other partners.

Sustainability of the research results is guaranteed due to the direct transfer of results into the financial services sector and the expected publications in national and international academic peer-reviewed media. D-Grid contains more projects to cover an even wider range of possible Grid communities. At the moment, the German Federal Ministry of Education and Research is in the process to install a third group of projects to bring Grid technology to more users and therefore improve sustainability of Grid technology.
The e-Infrastructures of the connected future

In a process that started with networks, several complex systems merging computing, data and other facilities have recently emerged under the common concept of an e-Infrastructure. They represent a further extension of Grids-infrastructures for computation, as well as data-intensive tasks and applications, thus creating a shareable collaborative environment with almost unlimited potential for further use. In the Czech Republic CESNET, the National Research and Educational Network provider (NREN), has been following this development road for a long time. The end result has been the integration of a number of research and development advances, ranging from optical networking infrastructures and middleware right through to advanced applications providing a complex national e-Infrastructure capable of supporting advanced, innovative applications.

Research into advanced high-speed networks, middleware and applications forms an integral part of CESNET’s work, reinforcing the fact that we are not focused solely on network operations. Indeed, CESNET’s R&D work encompasses areas as diverse as optical networks on the physical layer, middleware, and also Grid services and advanced applications.

With its optical network connecting all of the Czech Republic’s larger cities, CESNET has long been at the forefront of advanced network deployment. The current CESNET2 network backbone features a production core of 32 dense wave-division multiplexing (DWDM) channels that carry multiple 10Gigabit links. Some of these channels extend all the way to the network edge and particular applications, while others are used to connect universities and other academic and research institutions. Strongly committed to network research, CESNET also runs a separate CzechLight network, promoting the direct use of dark fibre through its own network device prototypes – like optical amplifiers and optical cross-connects. The CESNET network is also well recognised and respected across the international research community. CESNET is a core part of the pan-European GÉANT2 network and both participates in, and is also connected to, a

Although e-Infrastructures are a relatively new development, their potential is enormous. With an optical network connecting all of the Czech Republic’s larger cities, they can be built on further to bring benefits to many applications, writes Ludek Matyska from CESNET
While high-speed networking is an integral element in many of the other components of a complex e-Infrastructure, it nevertheless needs middleware components if it is to be useful to other applications.
The security systems that CESNET has researched and later deployed include authentication, authorisation and accounting mechanisms, as well as support for end users.

- Virtualising Grids, including interconnecting networks based on advanced networking facilities. The virtualisation of Grids has been intensively studied by a number of groups around the world in recent years, as it allows us to build computing environments tailored to users specific requirements. Building complete virtual clusters also requires the high-performance virtualisation of the interconnecting networks. While there are many virtual network implementations available, performance issues mean many of them are simply not suitable as Grid interconnects. The MetaCentrum team is thus working on a VirtCloud system that uses the CESNET2 network to prototype high-performance network virtualisation, and will also offer this concept to other NRENs.

- Low-latency uncompressed high-definition video distribution, which is based on programmable optical multicast switches. Facilitating the multi-point distribution of high-bandwidth multimedia is widely recognised as being a technically demanding challenge. CESNET has responded by developing a number of solutions that are now used by teams across the world; ranging from application-level programmable reflectors that can do specific processing for each individual user, to pure optical data distribution based on programmable optical multicasting cross-connects. Optical multicasting allows for effective operation, even over multiple wavelengths at once, thus allowing extreme-bandwidth applications to distribute the data to multiple locations with virtually zero impact on transmission latency.

- Inter-hospital storage system based on private optical network circuits. Medical storage based on Grids has been implemented by several widely-dispersed projects (e.g., BIRN, EGEE-supported MDM), but healthcare institutions are rather reluctant to adopt these systems because of strict privacy and security requirements. A number of hospitals have been, however, able to agree on building a shared PACS-enabled storage for medical imagery based on private network circuits built upon CESNET2 and Brno Metropolitan Academic Network (a metro network with architecture and implementation similar to CESNET2 network).

CESNET and MetaCentrum are forerunners in the search to develop a complex e-Infrastructure capable of covering networks, grids, and collaborative systems to support the ever-more demanding requirements of contemporary science.

This unique combination of network and grid provisioning, combined with our extensive research activities, planted the seed which has grown into the complex e-Infrastructure available today, something we aim to develop further in the years ahead.
Grid technology is in a critical transition, as it moves from research and academic use to wider adoption by business and enterprise.

As of now, the lack of business reference cases to persuade potential users is still hampering commercial exploitation of Grid solutions across the European Union (EU).

Increased general deployment of Grid technologies into the market will strengthen the EU’s competitiveness and leadership in this key area.

Therefore, the mission of BEinGRID is to establish effective routes to foster the adoption of Grid technologies across the EU and to stimulate research into innovative business models using Grid technologies.

The strategic objectives of BEinGRID are:

- To understand the requirements for Grid uptake in the commercial environment, involving software vendors, IT integrators, service providers and end-users
- To enable and validate the adoption of Grid technologies by business
- To design and build a Grid toolset repository with components and solutions based on the main Grid software distributions including: the Globus Toolkit, gLite, Unicore, Gria and basic Web Service specifications
- To develop and deploy a critical mass of Grid-enabled pilots, embracing a broad spectrum of economic sectors with different needs and requirements in terms of technological Grid challenges

Business Experiments

To meet these objectives, BEinGRID is undertaking a series of targeted Business Experiments (BEx) designed to implement and deploy Grid solutions across a broad spectrum of European business sectors (including the media, financial, logistics, manufacturing, retail and textile sectors).

The BEinGRID Consortium of 97 partners, led by Atos Origin, originates from countries all across the EU and represents the leading Grid research organisations as well as a broad spectrum of companies keen to assess the benefits to their productivity, competitiveness and profitability from their use of Grid solutions.
BEinGRID runs 25 BEs. Each one of these is a real Grid application, focused on specific business processes and addressing current customer needs and requirements.

The partnership in each BE cuts across the full value chain of the targeted economic sector – from technology providers to different levels of users. Involvement of end users and service providers in the vertical business experiments pilots is considered crucial to produce successful case studies. The results will support the transition of Grid technologies from an academic context to widespread enterprise adoption by enabling other enterprises to build on the success of the early adopters of Grid solutions.

Of the completed 18 first-phase BEs, numerous show very good potential as commercial products and services. Several partners are in the process of establishing them in their daily business or establishing spin-offs to specifically exploit them, standing as an example for other users.

By highlighting the scenario, solution and result for each one of these cases, as well as developing missing software and releasing best practice guides, the project encourages other end users in a similar situation to investigate the role that Grid technology could have for them. “I am very proud that the first phase of BEinGRID has produced such outstanding results,” said BEinGRID Project Coordinator, Santi Ristol. “Our many innovative end users, around whom we have developed these solutions, illustrate that Grid is business-ready”.

According to Francisco Campos, Senior Consulting Engineer at ICON, “ICON is pleased to exploit the benefits of the Grid as an end-user in the BEinGRID Business Experiments. We see Grid technologies as a key enabler for CFD to impact the effectiveness and productivity of SME companies and Original Equipment Manufacturers alike.”

As a second example, the ‘Virtual Reality for Architects’ application has

Our many innovative end-users, around whom BEinGRID has developed these solutions, illustrate that Grid is business-ready
Grid has helped in modeling Computational Fluid Dynamics - for instance with air interaction with car design

been developed to allow architects to provide customers with highly realistic models, through which they can navigate in real time. Allowing clients to explore the building is an added value, as they can better appreciate the design. Most innovatively, the application has been developed to allow the architect to work remotely - perhaps at the clients' site, and access the service on an on-demand basis - allowing greater financial flexibility. “Thanks to this application, we now benefit from unused resources in a simple way. This implies reduced processing time. Saving time during the processing phase, actually enabling us to increase and concentrate more on the test phase and reducing post-production related issues. We raise the customer's satisfaction and avoid a delay which, at the end, makes it a really cost-effective solution” confirms Isidore Zielonka, Partner, Art & Build.

Grid that goes beyond
Each BEinGRID use case clearly explains the business need for which the technology was developed, demonstrates the usability of the technology, identifies the technical innovation that makes it possible and compares all this to the existing industry solution. That is why all of them are a compelling and engaging argument that Grid technology is sufficiently mature for widespread commercial adoption. A compiled showcase of these use cases called Better Business Using Grid Solutions is available for download on www.beingrid.eu/casestudies.html.

Complementing this work, Gridipedia, a knowledge and toolset repository, has been developed consisting of Grid service components and best practices to support European businesses with the uptake of Grid. The Gridipedia website (www.gridipedia.eu) is currently seeing large growth and is populated with the results from the first phase of the project.

The research community has long been convinced of the benefits of Grid technology in the commercial sector. Furthermore, many projects have developed models of how a Grid-enabled society will interact and of the benefits for users of such an infrastructure. Consequently, much effort has gone into developing the technology and improving aspects seen as inhibitors of uptake – such as security and stability.

By accelerating the greater adoption of the technology in a wider range of sectors than currently seen, catalysing uptake, BEinGRID makes that foresight a reality.
Exchanges for Grid and Cloud Computing

Today’s business becomes increasingly computation intense. For example, before automobile manufacturers release a new engine, many simulations are executed to validate the properties of the new engine. Through the use of computer simulations, the development time can be shortened and the costs reduced. Since those simulations require a huge amount of computation power, an upfront investment in computers is necessary. However because of the high cost of ownership and the infrequent use of those computers, not all companies can afford it. For those companies, it would be useful to have access to a Computing Resource Exchange where they can buy computing resources at the daily rate. The supply of those computing resources comes from other companies or data centre providers. These kind of exchanges represents a significant advancement in the state-of-the-art of utility computing, where just one large provider of resources offers its resources (e.g. Amazon, Sun, Google, HP).

From the technical perspective, interconnection of computing resources becomes possible through Grid Computing technology. Grid computing denotes a computing model that unifies the processing power of an infrastructure that is dispersed administratively and geographically. Therefore, by using Grid computing, it is possible to set up virtual supercomputers by means of regular servers. The technology assures that adding and removing computers is quite simple, granting extreme flexibility in building up infrastructures quickly.

While the adoption of Grid technology in academia has been prospering, the adoption by commercial companies has been slow, mainly due to the lack of viable business models coupled with chargeable Grid services and commercial transactions on them. What is needed is a set of mechanisms that enables users to discover, negotiate, and pay for the use of Grid services. Since computing resource exchanges address this issue, they are, therefore, one of the crucial success factors for establishing commercial Grids.

Computing Resource Exchange

Quite recently, Amazon has floated the idea of Cloud computing with their offerings of Elastic Clouds. Since then, a few other companies started to offer similar services. An exchange for computing resources would have a significant impact on the current oligopoly-structured market, where a few providers (e.g. Amazon, HP, IBM, Google, Sun) can offer computing resources at prices higher than those possible in a competitive market structure. If buyers and sellers accept and trust the computing resource exchange for executing their trades, it will increase the supply of computing resources in the market. Consequently, it will lower the price for buying computing resources and computing resources will become even affordable to enterprises with a low budget.

The EU funded projects, SORMA and GridEcon, focus on the development of computing resource exchanges. While SORMA focuses on the openness of decentralised complex service markets, GridEcon addresses an exchange for basic Computing Cloud resources.

SORMA Exchange

The SORMA market is envisioned to be open with respect to the communication protocols and the local resource managers of computing resources. This openness allows Grid users accessing the Open Grid Market via well-defined interfaces. Furthermore, resource providers with different virtualisation platforms or with different resource managers can easily plug in the Open Grid Market. The idea is to set up a flexible market infrastructure, which can access resources over all existing kind of virtualisation platforms.

The openness is intended to offer the possibility of loosely integrating emerging Grid markets. For example, the Open Grid Market needs to combine platforms like Sun’s Network.com or Amazon’s Elastic computing cloud, but should also be capable of accessing Beowulf or MOSIX clusters. This approach should attract...
already existing resource providers such as Sun to plug in the Open Grid Market. Competition on such Open Grid Markets encourages markets to integrate and weed out too complex or inefficient platforms. The resource management for this kind of market is depicted in Figure 1.

Depending on the current demand for resources created by a Grid application, the user delegates the bidding process to an autonomously acting bidding agent. The bids are submitted to the Open Grid Market. Likewise, on the resource owner side, the bidding agents publish automatically available resources based on their predefined policies. The Open Grid Market matches requesting and offering bids and executes them against each other. The matches (i.e. allocations) are formulated in service level agreements (i.e. contracts). The fulfillment of the service level agreements will be automatically executed, while the Grid middleware is responsible for the resource provisioning and the payment system (such as PayPal) for the monetary transfer of funds. The SORMA project has been highly successful with the first prototype of the software soon to be available as a demo on the project website.

The industry partners in SORMA are representing consumers and providers. As a proof-of-concept, the applications from TXT Group and Correlation Systems are implemented on the SORMA Open Grid Market. In cooperation with Sun Microsystems, business models for providers are developed that consider pricing of complex services and pricing strategies.

**GridEcon Exchange**

In order to attract customers to the GridEcon computing resource exchange for commoditised computing resources and get the computing resource exchange concept accepted by users, the GridEcon exchange offers a set of services that makes the use of the exchange convenient, secure, and safe. The services, which we identified to be necessary for an exchange for commoditised computing resources, can be classified into GridEcon exchange services and value-added services (Figure 2).

Besides the core service of trading commoditised computing resources through a certain market mechanism, the exchange provider needs to offer additional services. They are necessary in order to make the GridEcon exchange work. Those GridEcon exchange services comprise provisioning of resource redundancy (i.e. to achieve service reliability and to improve the probability of a liquid market), monitoring capability for resource offers (i.e. to assure the quality of the goods offered comply with the quality standard set by the GridEcon exchange), simple access (i.e. to enable access to computing resources in a transparent and simple way), anonymity of sellers and buyers (i.e. to ensure that buyers and sellers do not make the transaction without using the exchange), and standardisation of computing resources (i.e. to offer commoditised computing resources).

The value-added services do not have to be offered by the GridEcon exchange provider but can be offered by independent service providers instead. The main value-added services that are developed by GridEcon are the Capacity Planner, the Fixed Price Quotation Broker, and the Insurance Broker. The capacity planning service helps buyers and sellers to make optimised planning decisions about purchases and sales of computing resource. It also supports users to optimally shape their demand and to find the appropriate resources for their applications. The fixed price quotation broker service allows users to sell and buy resources without the uncertainty of fluctuating prices. The insurance broker issues contracts against the failure of resources and compensates the user for the loss of a failed resource.

This set of services, built by GridEcon, will help establishing a market not only for accessing commoditised computing resources but also to sell spare computing resources. It also allows users to adapt their usage strategies of computing resources based on their demand and the supply of the market. This is a valuable alternative to the existing oligopolistic utility computing market.
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Dr Algimantas Juozapavicius describes how Lithuanian researchers are embracing Grid to push their scientific endeavours forward. They now rely on well-connected infrastructure, collaboration between researchers, and access to resources and experience to answer major scientific questions.

Grid technology driving Lithuanian research

"It is widely acknowledged that Grid computing has the potential to revolutionise academic research" – Dr. Andrew Richards (NGS, U.K.) stated. It is now common knowledge that Grid technology is attractive to the academic, the commercial, and many other sectors due to Grid’s ability to handle large amounts of data and enhance collaboration between people regardless of their location. Today many Lithuanian researchers agree with the statement by Dr. A. Richards and can verify how Grid technology improves research infrastructure in Lithuania.

The initial development of Grids in Lithuania was influenced by BalticGrid project (www.balticgrid.org) and started in the first half of 2005, when Lithuanian National Science and Studies Foundation initialised a research project to introduce and develop Grid technology for the academic community. Under this project products and services were developed comprising of:

- the LitGrid operational infrastructure and support, based on middleware LCG2 solutions,
- analysis and deployment of some parallel and distributed algorithms for various research applications of scientists,
- dissemination and management services. Also some research work was done for the analysis, design and implementation of applications, suitable for Grid infrastructure.

Based on these successful activities, the five year long LitGrid programme was created, with financial support of the Ministry of Education and Science of Lithuania. It started in 2007, aiming to develop the e-Science infrastructure in Lithuania, and to integrate this infrastructure into the emerging European Grid infrastructure. The products and services include:
• gLite-based infrastructure and support for partner's clusters, having different roles: as production clusters (tested on rules of EGEE and BalticGrid), as local clusters, given resources just for local user needs, as testbed clusters, enabling to develop some specific computing tasks,

• parallel and distributed algorithms, developed and deployed for research applications of scientists, integrating them into complex computing and data storage structures;

• computing resources and support for research projects of middle and large scale (like LHC CMS, COST P19, ITER, and others),

• methods and means for user interface (like Gridcom, SIG portals, visualisation tools developed in BalticGrid project),

• training and dissemination services for LitGrid users.

**Success stories for Grid**

The research in HEP (high-energy physics) and in ITER (International Thermonuclear Fusion Reactor), by scientists from Vilnius University and Institute of Theoretical Physics and Astronomy, were essentially stimulated by Grid infrastructure. HEP is based on CERN software CMSSW and is used by sharing Virtual Organisation CMS of EGEE infrastructure. In addition methods of object- and pattern-recognition, nuclear and sub-nuclear physics are used. ITER computing is based on software to compute many-electron atoms and ions for the evaluation of energy spectra and spectral characteristics, as well as modelling processes in low and high temperature plasma in order to support the fusion program diagnostics effort.

The task of Baltic Sea coast pollution (oil spills and biogenesis) modelling is a success story for scientists from Klaipeda University. By using Grid computing they were capable not only of expending

**Beside the everyday tasks for LitGrid such as to validate its infrastructure, to integrate different applications and to support these applications, LitGrid has ambitious plans for the future**

At present the LitGrid programme involves 13 academic institutions as partners (universities, research institutes, colleges). Each partner provides one or more clusters (in total it has 15 clusters, of heterogeneous architecture, with more than 400 CPUs, 21 TB of disk space). A supercomputer (SGI Altix 4700 with 64 CPUs and 64 GB of RAM) is attached also to gLite infrastructure, under the unique software solution.

One of the most important aims of LitGrid is to unite scientists from different areas of research, enabling them to exchange experiences accumulated, and to discuss and compare methods of computing, and also to disseminate best practices. A variety of areas of interest in LitGrid reflect the potential for Grid computing and the level of scientists’ demand for such infrastructure.

Research scope covering much more environmental parameters but also they managed to integrate the task with international programmes for Baltic Sea like BOOS and HIROMB. The computing now looks like a complex set of modern methods, which gives the advance prediction of sea currents and oil spill tracks in the part of Baltic sea, being adjacent to coasts. Grid technology also enables scientists to respond to specific requests from industry and environmental agencies in an applicable time. There is a potential to improve user perspective and build current and future operational models, such as an ecosystem model with more efficient networking and sharing of resources.

The scientists in material science and quantum chemistry consolidated essentially their research while turning to Grid technology. Their activities include computing of atomic, molecular and nano-structures in modelling of advanced materials, and lead to the discovery of substances with new features or new properties of matter. Software used in this context like Gaussian, Gamess, Dalton, and others, had to be redesigned and consolidated for Grid infrastructure, fitting more to substantial computing needs and to technological platforms, giving researchers more powerful Grid computing and modern program codes.

Engineering modelling is quite popular in LitGrid. It is performed mainly by scientists of Vilnius Gediminas Technical University and Kaunas University of Technology and includes expansion of software engineering tools and methodology into the area of parallel programming for Grid architecture systems. In addition to this context the design and development of visualisation tools for engineering tasks is a perspective activity for many applications, creating methods and tools for better software maintainability and leading to new Grid usage cases.
There is a linguistics application in LitGrid – Corpus of Academic Lithuanian. The aim is to provide a tool for discourse analysis for philologists with corpus search and analysis capabilities. The Grid is used to run efficiently search algorithms and algorithms for automatic text coding and annotating, for recognition of text parts, for recognition of correct text flow, for text annotation. The design and development of text corpora is closely related to text corpora in other countries (BASE and BAWE of UK, MICASE of USA, Parallel Corpora of Sweden).

The problem of user interface is often addressed in many Grids, also in LitGrid. In close cooperation with the BalticGrid the Gridcom tool for solving such a problem is intended to be used widely here. Gridcom is a web-based portal to store and launch applications, access storage elements, give a platform and tools for user groups to cooperate and to share applications. Gridcom includes: joint application repository for group of users, joint file repository for group of users, joint forum, mailing, audio/video capabilities, joint interface to visualisation and other tools, joint editing capabilities for files; other features. It automatically submits as many jobs as needed, resubmits aborted or failed jobs, collects results, gives possibilities for users to control the process of computing (even by using mobile phone).

It is now common knowledge that Grid technology is attractive to the academic, the commercial, and many other sectors due to Grid's ability to handle data.
Improved Grid applications makes for good chemistry

In recent years our understanding of chemical and biological science at a molecular scale has developed at a fast pace and had a marked impact on society at various levels. Information Technologies (IT) and massive data acquisition have forged a strong bond between science experiments and computer use. This has led to a high intensity of throughput for chemical design, microarray analysis, device technology, physical and chemical analysis processes, combinatorial chemical synthesis, and screening.

The resulting volume of data demands a systematic approach to making this data available through common user interfaces to scientists and researchers as manageable, widely distributed and accessible units. While the Grid is thought to be the most efficient channel for such capabilities, work on devising applications and collaboration frameworks for users is also vital if the Grid is to be used to its full potential. This is, therefore, the primary target of the Chemomentum project.

Project aims
The Chemomentum project, funded by the European Union (EU), aims to exploit the state-of-the-art powerful Grid technologies and infrastructures for the solving of challenging real-world problems in computational chemistry. Specifically, the project, in the form of the Chemomentum system, will be used for the evaluation and assessment of risks to human health and the environment from exposure to chemicals prior to their widespread commercial use.

Traditionally speaking, to undertake such a task in accordance with official standards requires a considerable investment of time and money, not to mention animal testing. However, with the introduction of Grids, it becomes possible to reduce such investments considerably via providing parallel assessments in silico.

The Chemomentum system, exploiting the appropriate Grid technologies and associated infrastructure as it does, has the potential to boost time-effectiveness and to reduce the need for animal testing in this area by providing powerful solutions for the in-silico computational testing of chemicals.

The right tools for the job
The first generation of chemoinformatics tools, created in response to the growth of large-scale experimentation data, fell short of meeting the requirements of researchers and were therefore not widely adopted. These requirements, in effect, were the capability to effectively integrate services for risk assessment, toxicity prediction and drug design. The system also provides an integrated Grid solution for workflow-centric complex applications with a focus on data management and knowledge whilst paying careful attention to providing end users with powerful tools in a natural and transparent fashion.
data, information and knowledge with the use of transparent toolsets. It became clear that new algorithms and data analysis tools capable of exploiting the existing computational power for more detailed chemical analysis was needed.

Further challenges could be seen in the information technology used, including superior visualisation, more effective access to the existing repositories of data, and mechanisms for the transformation of raw data into interpretable and predictable scientific information. Researchers also needed to demonstrate parallel workflows in order to facilitate general access.

Over recent years the Chemomentum project has been working to these aims and developing middleware and end-user interface technologies to enable both novice and advanced users to access the capabilities of sophisticated scientific applications running on large-scale grid computing resources. The beauty of the Grid is that it allows participating parties to select and share distributed resources across multiple organisations in order to form a networked combined 'attack' on large computational problems.

Additionally, Grid middleware can be used for the development of tools such as web interfaces, portals, web services and integrated workflows, which enable the automation of low-level processes and provide interfaces to scientific applications. Over and above sheer computational power, the Grid is all about distributing resources across administrative domains and sharing information with between the various users.

Web-based interfaces enable users to make the most of such a shared distribution. Indeed, tackling massive data-intensive problems through running large simulations is no longer the sole domain of large computational centres. Instead, with such a system distribution, the task and the associated enormous banks of data can also be accessed by clusters, workstations and individual PC users.

The key is a common and uniform user interfaces that spans all platforms. With the recent the recent technological advancements, and the associated Grid environment and wide use of services paradigm, this is possible.

Intuitive and flexible

Chemomentum’s workbench has been designed to allow access to tools that focus on computational prediction, as well as to provide data handling, in an efficient, reliable and transparent manner, by way of intuitive task-oriented interfaces.

The system is based on UNICORE middleware, which implements Grid Services technology. The flexibility of UNICORE enables usage for different applications. The benefits for the Chemomentum project are many. For instance, UNICORE is easy to deploy, configure and administer, and supports a wide range of operating systems and batch schedulers. UNICORE provides a robust, standards-compliant Grid software stack, excellent performance and scalability, and a flexible security architecture.

The Chemomentum project, funded by the European Union (EU), aims to exploit the state-of-the-art powerful infrastructures of Grid technologies and apply them to real-world challenges in computational chemistry.
Capabilities for in-silico design and modeling in chemistry and life sciences are enabled in the Chemomentum workbench. The system also provides a general Grid solution and can be adapted to diverse application domains. The concept of VO (Virtual Organisation) allows for easy decentralised user management via a dedicated service that provides user-friendly interfaces.

A highlighted feature of this system is the advanced workflow management functionality, which enables the creation of subtasks that can be run in diverse ways. In addition, the data management system offers a wide range of possibilities for storage and retrieval of data and metadata. Metadata is not limited to a specific scientific domain, but can easily be adapted to any applicable scenario.

**In line with REACH legislation**
Chemomentum has the advantages of reproducibility and transparency, which makes it fully compliant with REACH (Registration, Evaluation, Authorisation and Restriction of Chemical substances) legislation. The legislation strictly stipulates reproducibility in the data prediction (i.e. the same property value for a specified compound can be produced by the model at any time by any given user).

A large variety of results can occur in computational models when, for example, a manual optimisation of a 3D molecular conformation is requested or when users can choose from a palette of options.

Avoiding such a scenario is one aspect of the REACH regulations, thereby enabling a standard level of predictability and reliability. Chemomentum intends to expand the platform to include additional features, such as improved APIs (Application Programming Interfaces), enhanced regulatory capabilities, and continued improvement of computation and data analysis capabilities enabled through visualisation.

The universities involved in the project provide top level expertise and knowledge from all areas necessary for the project. University of Tartu brings knowledge of modelling the properties of compounds. It develops methods for efficient use of statistical methods in chemical and material design and in Life Sciences. The Technical University of Dresden provides the consortium with expertise in knowledge management and knowledge discovery, data management and related areas. The Ulster University brings its research excellence in biomedical sciences, bioinformatics, data warehousing and data mining. The University of Zurich has built a number of tools for computational chemistry and has considerable experience in the area of computational Grid technologies and their integration with applications and complex workflows. All are well acquainted with UNICORE and other grid middleware systems.

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**At a glance**

**Full Project Title**
Chemomentum

**Project Partners**
The Chemomentum Consortium contains nine partners:
- University of Warsaw;
- Juelich Research Centre;
- University of Tartu;
- Technical University of Dresden;
- Ulster University;
- University of Zurich;
- The Marco Niegri Institute for Pharmacological Research;
- Biochemics Consulting;
- TXT e-Solutions

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www.chemomentum.org

University of Warsaw draws upon creative scientists and has an extensive experience in Grid computing. Warsaw University currently develops high level services and portal tools integrated with Grid middleware. The Research Centre Juelich is one of the key developers of UNICORE technology and is the coordinator of the UNICORE SourceForge initiative.

The Mario Negri Institute for Pharmacological Research is a scientific organization for research and education with a focus on computational predictive toxicology. IRFMN will test and use the system for applications in the context of toxicity prediction and environmental risk assessment. Biochemics Consulting and TXT e-Solutions strengthen the consortium by contributing expertise in the requirements of industrial users. They will make valuable contributions to the project's dissemination and exploitation activities.

**Piotr Bala**
Piotr Bala is Professor at ICM University of Warsaw and at Faculty of Mathematics and Computer Science N. Copernicus University.
Widening the Grid benefits across continents

Research and innovation are two of the cornerstones of sustainable economic growth. As such, supporting intellectual leaders in their efforts to advance research into areas of their choice is crucial to our prospects of building a prosperous long-term future. Such areas typically relate to the needs of Industry, society, or strategic national interests, and it is this broad spectrum of powerful stakeholders that is pushing forward research and technological development. Research into a particular area of science and technology requires real synergy between all of the parties concerned if it is to achieve its aims, and such a collective effort can help a country generate the kind of momentum which will encourage and stimulate further development.

A prime example is provided by India, a country that is home to a rapidly growing base of technological knowledge and which has the potential to become a global innovation leader. However, while the country’s economic potential is well documented, India cannot be expected to roar towards this objective like one of its native tigers. On the contrary, in the words of the renowned Indian writer and management consultant Gurcharan Das, “it will advance like a wise elephant, moving steadily and surely towards the future.” To this we may add a further element. When assessing the impact of a moving object, knowledge of the speed alone is insufficient to gain an accurate measurement, what really matters is the momentum, i.e. the product of speed and mass (an elephant typically weighs twenty times a tiger).

However, effective coordination between the various research efforts is a must if this development momentum is to be built and maintained. This importance is further reinforced by Dr. R. Chidamaram, the Principal Scientific Adviser to the Government of India, who views ‘coherent synergy’ as being a particularly crucial element in national economic development, something in which he recognises that e-Infrastructures and international co-operation can play a decisive role. These are considerations which led directly to the development of the EU-IndiaGrid project. From the very beginning, international co-operation has been at the core of the EU e-Infrastructures
strategy. EU-IndiaGrid, whose aim is to create bridges between e-Infrastructures in Europe and India, represents an essential element in this overall goal of increasing scientific collaboration.

**Technology is power**
The EU-IndiaGrid Project Conference, held in conjunction with the e-Science 2007 International Conference in Bangalore, was one of the first opportunities in which the key players in the project could gather together and discuss e-Infrastructure development at a national level. Dr. Chidambaran was one of the keynote speakers at the event, and in his speech he gave some idea of the extent of India's technological ambitions. “India can become a global innovation leader, provided we show ‘technology foresight’ to make the right technology choices, provided we introduce ‘coherent synergy’ in our science and technology activities and provided we establish an effective ‘innovation ecosystem,’” he said, before going on to add that he sees international cooperation on large-scale scientific collaborations as a must for India. The EU-IndiaGrid project has a key role to play in these terms, and particularly in fostering and enhancing cooperation between National Grid Initiatives in India and their major European Grid initiatives.

Nor is Dr. Chidambaran alone in his views, as international cooperation is at the core of the EU e-Infrastructures strategy. Building on the success of world-leading research and Grid infrastructures, such as GÉANT and EGEE, e-Infrastructures foster more efficient scientific collaborations worldwide and bear the promise of revolutionising the way research is carried out. Within this framework EU-IndiaGrid is accelerating EU-Indian collaboration in e-science and mobilising actors on both sides extremely effectively, bringing clear benefits in a variety of scientific disciplines. This way synergy with Indian research infrastructures will become, together with other successful international cooperation projects, an important building block for future global virtual research communities.

**Linking research communities**
However, the work outlined above is enormously complex, and thus strong foundations must be laid in order to ensure its reliability and also to establish a sound basis on which further collaborative work can be built. As such the EU-IndiaGrid project is playing a key role in encouraging co-operation between GARUDA (a major Indian Grid initiative), regional Worldwide Large Hadron Collider Computing Grid (WLCG) Projects, and also EGEE – the major European Grid Initiative. Significant progress has already been achieved, and yet this does not imply any lessening of EU-IndiaGrid's commitment to innovation. This ‘bridging’ work between European and Indian Grid infrastructures has become a crucial element in scientific collaboration, and we now have the opportunity to improve it further thanks to the recently approved plan for a multi-gigabit, low latency, e-Infrastructure: the National Knowledge Network (NKN).

The NKN project is a major step forward for Indian research, as it represents the first step towards developing an ICT-based infrastructure capable of connecting the major laboratories and research centres across India. A number of major applications, including education, health and agriculture, are seen as being key areas for the NKN, which builds upon Europe's experience of establishing e-Infrastructures – the spinal cord of the European Research Area – across the continent. Indeed, the European experience holds many lessons for India, and the EU-IndiaGrid project is working to ensure that the knowledge that has been gained is fully utilised.

The enhancement of Europe's supercomputing facilities, mainly in the research environment, played an important role in the creation of e-
At a glance
Project Title
EU-IndiaGrid – Joining European and Indian Grids for e-Science Network
Community

Project Partners
- INFN - Italian National Institute of Nuclear Physics (coordinator)
- Abdus Salam International Centre for Theoretical Physics ICTP - IT
- Bhabha Atomic Research Centre - IND
- Cambridge University - UK
- Centre for Development of Advanced Computing, C-DAC - IND
- Consortium GARR - The Italian Academic and Research Network - IT
- Education and Research Network,ERNET - IND
- Metaware SpA - IT
- SAHA Institute of Nuclear Physics Kolkata - IND
- Tata Institute of Fundamental Research Mumbai and National Centre for Biological Sciences - IND
- University of Pune - IND
- Variable Energy Cyclotron Centre, VECC Kolkata -IND

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Grid Computing and e-Infrastructures have had a profound impact on research and business activities over the last decade, and the prospects of further development and of major research questions being answered are bright.

Indeed, such are the benefits offered by e-Infrastructures that collaborative work between Indian and European researchers, enabled by the EU-IndiaGrid project, is already well underway. Under the Indo-European programme ‘Collaboration in the area of IT’ – ERNET has been connected with GÉANT, the European Research Network, through a 100 Mbps dedicated circuit. This is the first direct network link between India and Europe, and it has already played a fundamental role in enabling Indian Universities, Colleges and other educational institutions to share information and collaborate with their counterparts in Europe. In a demonstration of its own commitment to development, both the European Union and the Indian authorities are providing the project with significant funds, further underlining the broad-based consensus on the importance of e-Infrastructures and their ongoing developments.

Meanwhile, an additional high-speed international link for the Large Hadron Collider (LHC) at CERN has been funded by the Indian Government. The start-up of LHC, on 10 September, provided a further boost to Euro-India collaboration in scientific research, and the development of the e-Infrastructures will allow Indian researchers to contribute fully to this project, which represents one of the world’s largest research achievements.

Grid Computing and e-Infrastructures have had a profound impact on research and business activities over the last decade, and with more brains, working on more ideas, in more places around the world, the prospects of further development and major research questions being answered are bright. The world is growing ever more reliant on ICT technologies, which are employed nowadays across a wide variety of fields and sectors – commerce, government and culture to name just three – making their ongoing development a consideration that no country can afford to ignore. When international research partnerships are established to address global scientific challenges, particularly those that have a high societal and economic impact, it is clear that e-Infrastructures are crucial to their prospects of fulfilling their objectives.

As such e-Infrastructures are integral to the global economy, which only reinforces our determination to continue along the development path in the search for ongoing improvements. ✪

Biology: the folded state of the Advillin protein as calculated on the EU-IndiaGrid infrastructure overlaps almost perfectly with the protein structure determined experimentally.
Assessing the risk in external Grid Technology

Grid Technology is widely known in scientific research, industry and business. The AssessGrid project’s revolutionary new software gives providers and customers the ability to weigh up the risks and makes the process far more user-friendly, writes Mélanie Biette.

Grid computing is a relatively newly-developed technology for the distributed storage and processing of data, but its impact on the provision of virtualised access to large-scale computing resources to a wide spectrum of users has been immense and it’s now being used in the corporate, social and academic landscapes with great success.

Grid infrastructure supports a wide variety of applications, from test-bed projects to deployment and management. Its development has been particularly rapid in Europe, backed by regional, national or European public initiatives like BalticGrid, D-Grid (Germany) and GEANT. Grid efforts have begun to interoperate more and more around the globe, resulting in even higher worldwide infrastructure capacity than would have been available in local clusters and individual centres.

The advancement of Grid computing is attracting more and more interest from business and industry. Rolls Royce, for example, uses a Supercomputing centre based at the University of Stuttgart (HLRS) to help it handle its computer simulations and telecommunications companies are increasingly using Grid technology.

There are only a few companies, however, offering ‘on demand’ Grid computing facilities, Amazon for example, although the numbers will inevitably rise.

Amazon Web Service has a new web service called ‘Simple Storage Service’ (S3). It is a storage service backend for software developers. Moreover Amazon offers to the end-users the possibility to use resizable compute capacity with its ‘Amazon Elastic Compute Cloud’.

As for end users, the possibilities of Grid seem endless. At the moment, Grids are widely used in the health, financial, transport and communications sectors, while its impact on disaster management is only just beginning to be realised.

A crucial issue facing end-users in general, however, is one of security and confidentiality, particularly in Utility Computing. Renting shared resources is seen as a big risk factor for many. But for analysts of the sector, the benefits far outstrip any risks: Grid is virtualising resources and making them more efficient. Grid technology appears as a means to limit under-utilisation, putting resources together and hiding them behind a tool – middleware – which gives end-users access to the resources in an easy to manage manner.

Igor Rosenberg, software engineer for Atos Origin, one of the AssessGrid partners, likes to point out the many advantages Grid usage has: “Imagine an architect working on a complicated 3D model of a new building. As well as the time it takes him to design it in the first place, his computer may take several more hours to render and reveal the design of a building he has designed. That’s a long coffee break!”

“In order to speed this up the architect can now utilise Grid technology and do the same rendering on several computers. Grid gives everyone access by sharing resources.”

Of course, as with any implementation of any new technology in both the public and private sectors, despite the many benefits on offer there are risks.
The AssessGrid project has already developed prototype software which introduces risk-assessment to the Grid, giving providers the ability to assess demand.

Attached to making the huge investments needed. This has led to the development of a system whereby extra computing capacity is bought as needed, a system known as Utility Computing.

Sun Microsystems provides such a service with its Sun Grid Compute Utility. The company describes this as "a simple-to-use, simple-to-access data centre-on-demand" This is IT as a service, provided over the Internet and it is undoubtedly the way forward, but there are still problems. At the moment, potential system failures or operator problems could result in a Grid resource being unavailable just when clients need it for complicated simulations or 3D models to be completed. Problems like this do not build trust in a brand and this is where AssessGrid's new software plays its part.

The AssessGrid project is a collaboration project involving the Technical University Berlin (Germany), Paderborn Center for Parallel Computing (Germany), CETIC (Belgium), IAMSR, ABo Akademi University (Finland), Atos Origin (Spain), Wincor Nixdorf (Germany) and the University of Leeds (UK).

The AssessGrid project has developed prototype software which introduces risk-assessment to the Grid, giving providers the possibility to evaluate the business risk associated with providing a specific service. This is measured as a Probability of Failure, quantifying the risk taken by the provider.

With the growing demand of Service Level Agreements (SLAs) for Grid products, the lack of any risk assessment capability has meant that providers may end up paying a penalty fee as well as suffering a negative impact upon their company reputation when problems like this occur.

In terms of Grid, however, SLAs are just coming to the market and what the end-user usually has is an SLA based on time and an agreement between companies. SLAs are not flexible enough and the system also makes it difficult for the provider to judge how many of its resources will be needed and, therefore, manage the demand.

A pay-per-use system calculated on an individual-user rather than company basis would appear to be a far more flexible and useful approach that benefits both the user and the provider and this is something AssessGrid has established, simultaneously allowing providers to accurately assess demand, and make SLAs more effective.

The AssessGrid Consortium is designing an SLA framework where SLAs are specific to individuals. Thanks to the framework, each user can choose a provider based on quality and price given. It looks like creating a market place and putting the providers in competition with each other. As well as the development of these 'bespoke' SLAs, AssessGrid has also developed and now offers an extension to the Utility Computing model by adding a new functionality in the form of a broker and thus extending the idea that computing capacity is based on customer needs and billed accordingly. This creates a far more vibrant marketplace while the broker is there to facilitate the whole process.

The Consortium sees this as a natural development in the commercialisation of Grid technology in the sense that the idea of the broker isn’t new, but in the context of Grid, it is. Mélanie Biette, exploitation manager at AssessGrid says: “There’s no commercial broker in Grid computing yet,” she explains. “At the moment all relationships are one-to-one rather than one-to-many relationship.”

“One aim of AssessGrid software is to enable this one-to-many relationship by...”
allowing the broker to help the end-user access the information needed to choose between providers.”

A good example of seeing how this broker system works well is in the computer-intensive finance sector, where high-process capacity is needed to launch prediction simulations of, for example, financial flows on the stock exchanges around the world. Grid computing is perfect for this situation, increasing the speed of these simulations, so providing a leading edge for the institution using it. The capacity is there and the broker will negotiate the use and the price agreements for the many institutions using it as they need to.

The partners of the project have developed three business models to illustrate the integrated broker system further, using a series of real scenarios to show how it could work in the business world.

The trusted consulting party model

In this model the broker is consulted by the customer to check the viability of the resource provider by establishing its Probability of Failure (PoF) on results of previously performed services. An IT Consultancy, or in longer term a start-up business, could add the broker service in its offer.

The intermediate party model

The broker, in this scenario, looks for providers’ offerings best suitable to the customer need. The customer then chooses the best offer and directly negotiates the terms of the SLA with the provider.

The virtual provider model

In this case the broker offers its own service through a SLA to the customer after combining the services of several providers in a workflow of tasks.

The use of a broker in these models adds significant value to the utility computing model and AssessGrid Consortium believes the broker will have a compulsory role in a free Grid market.

The portal

One final element of the AssessGrid architecture is the user-friendly web portal. It allows people access to the providers, and the ability to switch between them to ensure an uninterrupted supply of computing power if, for example, one source is busy.

Conclusion

The AssessGrid project has been highly successful with the first prototype of the software already available as a demo on the project website. In terms of future trends in the Grid marketplace, it confirms the need for the approach taken by the project. The global market for Grid and the Utility Computing model are still immature, but by inserting risk assessment in SLAs, AssessGrid will increase adoption.

The project stays closely aware of and responsive to future trends in Grid computing. While the market for these trends – green, sustainable IT, cloud computing and Service Oriented Architecture, for example – is in its infancy, AssessGrid is well positioned to play a vital role in their development: risk needs to be assessed in all those domains.

Utility Computing is a solution for the efficient use of IT. Paying for the resources that really have been used instead of investing and managing infrastructure is a way to save energy and costs. Cloud computing, a new label for a subset of Grid computing that includes Utility Computing and the use of shared computing resources and, of course, Service Oriented Architecture (SOA), which is inextricably linked with Grid can also benefit from AssessGrid outcome.

AssessGrid answers to real needs of improvement of the SLAs in order to improve global Grid expansion and commercialisation. It is innovative and needed in the Utility Computing model, while the AssessGrid broker functionality will be an independent role once the Grid market becomes free and open.
Developing the business end of cloud computing

The Fraunhofer Gesellschaft recognised the importance Grid technology for industry early, and started its first internal projects back in 2001. From the very beginning the focus had been on a service oriented and easy to use Grid environment. The Fraunhofer Resource Grid – the operational basis for the Fraunhofer Grid Alliance – which puts its focus on resources rather than pure computing devices was founded and developments of powerful software components started.

In 2003 the precursor of what is called today PHASTGrid went into production at a large European Bank and is today managing high throughput computations of a few thousand Cores in 24x7 operation mode. The quite abstract concept of the Fraunhofer Grid Workflow engine GWES turned out to be successful and became part of a series of European and German Grid projects. As a consequence Fraunhofer ITWM, IAO, SCAI and FIRST started the ‘Enterprise Grid’ project in which Fraunhofer invested two million Euros with the intention of garnering industry contracts to the tune of three million Euros. This year the project ended successfully with a significant return of already more than two point five million Euros.

PHASTGrid – ready for the Cloud

PHASTGrid developed at the Fraunhofer Institute for Industrial Mathematics (ITWM) is a lightweight fully service oriented middleware for reliable high throughput computing in industry. The name stands for Parallel, High Availability and Throughput , Scalability and Fault Tolerance. Based on standardised technologies from the web services community it is highly optimised to guarantee high throughput at low latencies and offers an internal parallel framework (transform – execute – aggregate, which includes Google's Map Reduce), that allows a huge variety of parallelisation approaches to speed up single core applications by a few orders of magnitude, which is essential in applications for the financial services, or oil and gas sector.

The fundamental difference to Globus and other Grid middleware is that PHASTGrid requires that the applications are integrated and presents to the user an application web service and a WEB DAV interface to upload or announce data to the storage manager.

Behind the service gate we have a trusted zone.

Through a discovery and topology service PHASTGrid can easily use AMANZON EC2, and runs on resources like a Cell based cluster. What's more, the standard firewall problems do not exist within PHASTGrid.

CALANA – a simple but powerful solution to the meta scheduling problem

Calana provides a marketplace for computing resources and jobs. In an auction process users announce their requirements and software agents can offer their resources according to a policy determined by the resource provider. Calana dynamically creates a price for their offering. The Calana marketplace then selects the best resource for the user's needs and monitors the execution of the job. CALANA can be used within PHASTGrid to select the cheapest or fastest resource within the PHASTGrid enabled world.

Using ISV software in compute clouds: Licensing made easy

Today, most software vendors have constructed their licensing models with full access to the computers in mind:
Hardware dongles have to be installed or a networked licensing server issues temporary licenses. In cloud computing, this is no longer feasible: if one uses a credit card to rent compute resources on demand, providers like Amazon dynamically create an appropriate resource. Often, it is technically or legally not feasible to use existing software licenses on these on-demand resources.

The Fraunhofer ITWM has developed and patented a new licensing paradigm for on-demand licensing. In order to help ISVs to offer cloud-enabled software licenses, the Virtual Licensing Toolkit provides a flexible yet easy-to-integrate framework. Customers can ask for licenses on demand, for example in order to obtain a license for a specific job. The license can then be used with every computer infrastructure – both locally and in the compute cloud.

**Fraunhofer Grid Workflow Engine: GWES**

The Grid Workflow Execution Service (GWES) is the workflow enactment engine originally implemented for the Fraunhofer Resource Grid (www.fhrg.fraunhofer.de) and enhanced for Enterprise Grids (www.epg.fraunhofer.de). It is today used as well in Grid projects like Instant Grid (www.instant-grid.org), MediGRID (www.medigrid.de), and BauVOGrid (www.bauvogrid.de) and integrated with commercial applications. The GWES coordinates the composition and execution process of Grid workflows. It implements a highly dynamic workflow concept by means of the Grid Workflow Description Language (GWorkflowDL), which is based upon the theory of high-level Petri nets. The main purpose of the Grid Workflow Execution Service and its client interfaces is to enable users to automatically execute workflows on distributed resources without being bothered with implementation-specific details, putting more attention to the functionality of the workflow itself. Therefore the Grid Workflow Execution service provides methods to initiate and analyse Grid workflows, and to coordinate and optimise the execution of these workflows on distributed and in homogeneous resources regarding the control as well as the data flow. Abstract operations are automatically mapped onto matching software and hardware resources, triggering web service operations, remote executions of programs, or file transfers. The workflow service supports pure Web Services, PHASTGrid, the Globus Toolkit 4, and it is easily extendible for further execution platforms (www.gridworkflow.org/kwfgrid/gwes/docs/).

**PHASTGrid use cases in oil and gas industry and financial services**

The most prominent use cases for PHASTGrid are provided by the oil industry and the financial sector. Both are characterised by the deployment of large distributed compute resources.

The financial market is dominated by Monte Carlo (*) simulations with single core runtimes of minutes for full-blown complex derivatives including greeks. The data load is usually not very demanding but a very high throughput and low latency is required.

Oil and gas applications like Kirchhoff or FD Migration show runtimes from days to weeks on a full cluster, have demanding I/O requirements and usually lack failure tolerance.

As already mentioned PHASTGrid is in production in the financial sector. Parallelisation can easily be integrated within PHASTGrid and through dynamic job partitioning acceleration factor to individual jobs by a few orders of magnitude.

In the seismic world we deployed it as seismic processing architecture. Compute intensive workflows requiring more complex I/O pattern as in the financial market and the need to run on accelerating hardware like the IBM Cell Processor profit from the very flexible workflow engine GWES and the PHASTGrid storage manager.

The internal parallelisation capabilities, the use of standard protocols and interfaces together with the high throughput and the ease of installation are the main assets of PHASTGrid in these areas. ★

* Monte Carlo methods: A class of computational algorithms that rely on repeated random sampling to compute their results.

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**At a glance**

**Full Title**
Fraunhofer Institute for Industrial Mathematics (ITWM) Competence Centre for High Performance Computing and Visualisation

**Project Objectives**
Contract research and development in the areas:
- Service oriented computing
- HPC in the oil and gas sector
- HPC tools

**W**: www.enterprise grids.fraunhofer.de

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**Dr. Franz-Josef Pfreundt**

Department Head of the Fraunhofer Institute for Industrial Mathematics

Dr. Franz-Josef Pfreundt studied Mathematics, Physics and Computer Science resulting in a Diploma in Mathematics and a Ph.D degree in Mathematical Physics (1988).
In 1995 he became Department Head of the Fraunhofer Institute for Industrial Mathematics – ITWM. At the ITWM he founded the departments: Flow in complex structures and Models and algorithms in image analysis.
Since 1999 he is Division Director at Fraunhofer ITWM and Head of the Competence Center for HPC and Visualisation. He has been given both the Fraunhofer Research Award and the IBM faculty award.
**Challenges tackled in race for global super-computer**

**In the last** decade, the astonishing growth of the internet and the extent to which we rely on computers as an integral part of our everyday lives has been nothing short of a phenomena. And yet, this phenomenon is still in its infancy. We might be able to make predictions, but we do not truly know where the next decade will take us in terms of possibilities for the internet. And if we consider the industry in 50 and 100 years’ time the prospects are truly mind-boggling.

One shorter term possibility is that of a global computer on a grand scale. This would comprise internet-connected computing entities, possibly mobile and with varying computational capabilities. The computer would be globally available and able to provide its users with a rich menu of high-level integrated services that make use of its aggregated computational power, storage space and information resources.

Obviously, there are huge challenges in being able to create, operate and exploit such a super-computer on a vast scale. One way is to introduce an intermediate layer otherwise known as the overlay computer.

The goal of the AEOLUS project is to investigate the principles and develop algorithmic methods for the construction of an overlay computer that will enable efficient and transparent access to the resources of an internet-based global computer.

The main objectives for the project, which was launched in September 2005 and will run until August 2009, include the identification and study of the problems, and corresponding algorithmic principles, related to overlay computers running on global computers. The team are also keen to identify the important functionalities that an overlay computer should provide as tools to the programmer and to develop, analyse, and experimentally validate algorithmic methods that can make these functionalities efficient and fault-tolerant.

Additionally, the project aims to provide improved methods for communication and computing among wireless and possibly mobile nodes so that they can transparently become part of larger Internet-based overlay computers, and to implement a set of functionalities and integrate them under a common software platform. This can then provide the basic primitives of an overlay computer, as well as build sample services on this overlay computer, providing a proof-of-concept for the theoretical results.

**Workplan**

The work within AEOLUS is divided into six components which define corresponding subprojects SP1-SP6:

**SP1 Paradigms and principles.** This aims to develop the theoretical framework to cope with new algorithmic problems that arise in Global Computing. It studies structural properties of global/overlay computers, fundamental techniques for coping with selfishness and for achieving stability and fault tolerance, and tackles the challenge of computing with partial knowledge by blending theories from economics, game theory, algorithmics and combinatorics.

**SP2 Resource management.** This focuses on specific aspects related to the
management of critical resources, resource discovery, as well as on the design of mechanisms for accessing resources owned by selfish entities. Resources can either be of a low-level (i.e., infrastructure-dependent) or application-level.

SP3 Sharing information and computation. This considers algorithmic problems related to the management of resources focusing on computational and information resources. It addresses issues like distributed data management, load management and scheduling while studying in depth the resource usage and management issues posed by the Global Computing Proactive Initiative.

The goal is to investigate the principles and develop algorithmic methods for the construction of an overlay computer that will enable efficient and transparent access to the resources of an internet-based computer

SP4 Security and trust management. This explores problems related to trust management, authentication mechanisms, privacy, anonymity, and secure distributed computation. Fundamental issues crucial to a transparent security layer are addressed. In achieving this goal, the work within SP4 adapts concepts from cryptography and economics that have recently shown to be very successful in modelling adversarial but rational behaviour.

SP5 Extending global computing to wireless users. This investigates how to transparently include wireless nodes in an Internet-based overlay computer. It focuses on issues like resource management and quality of service in wireless sub-networks, network design and topology control under dynamic scenarios, mobility and fault tolerance. SP5 aims to provide efficient and practical algorithmic solutions for high-quality, reliable, stable end-user services on heterogeneous wireless networks. Due to the specific limitations of wireless devices, particular attention is placed to the efficient usage of critical resource like energy and spectrum.

SP6 Design and implementation of components and applications for programmable overlay computers. This aims to implement and integrate functionalities produced covering all the above areas of research into a common software platform (the Overlay Computing Platform) that will provide the programmable interface of the overlay computer. Special attention is devoted to the efficiency of the implementations. An application implemented on top of this overlay computer will serve (together with the platform and the integrated functionalities) as a proof-of-concept.

Designing and implementing components and applications for programmable overlay computers has impact on the research conducted in all research areas addressed within AEOLUS which reversely supply the proof-of-concept with functionalities as well as corresponding algorithms to be included in the Overlay Computing Platform. The selection of the overlay computer also identifies key areas on which theoretical and experimental research focuses.

Expected results

- Formulation of algorithmic principles for overlay computers
  - understanding of models
  - design and analysis of provably efficient algorithms
  - statements of trade-offs, impossibility results and lower bounds
- Implementation of functionalities
- Integration of functionalities into a common platform to serve as the General-Purpose Programmable Overlay Computer
- Proof-of concept application

AEOLUS has just completed its third year. Obtained results so far include an experimental version of the platform while particular results have appeared in approximately 600 original scientific publications.

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Christos Kaklamanis is a Full Professor in the Department of Computer Engineering and Informatics at the University of Patras. He gained his Ph.D. in Computer Science from Harvard University in 1992. He previously worked as a Postdoctoral Fellow at DIMACS and as a research consultant for NEC Research Institute. His main research interests are Parallel Computation and Communication, and the Design and Analysis of Algorithms.

AEOLUS
A search engine that talks your language

Information has never been more easily accessible than it is today. Search technology has advanced to a point where the mere click of a mouse or touch on a screen brings both mobile phone and computer users reams of in-depth information on virtually any topic they might choose, and our growing reliance on search engine technologies has made companies like Google and Yahoo! some of the most powerful businesses on the planet.

Nevertheless, Bernardo Magnini of the Qall-Me project (Questions answering learning technologies in a multilingual and multimodal environment) believes there is still potential for improvement in information access systems, particularly in terms of their ability to respond to users specific linguistic needs.

“We are now at a state of technological maturity where we can look more closely at the generation of new information access systems, where question answering (QA) is the framework around which several technological innovations can be profitably integrated,” he says. “Qall-Me has taken up this challenge. We aim to demonstrate the potential of QA in real usage contexts where people can ask natural questions in their own languages and obtain short, precise answers.”

This latter point hints at one of the main shortcomings of existing search technologies. Users everywhere find that internet searches often generate enormous amounts of information, large proportions of which are likely to be unrelated to the original search topic or the user’s specific needs. Vicedo says this is a problem which has its roots in the underlying search engine processes. “Current search engines mainly return documents (or more
We aim to demonstrate the potential of QA in real usage contexts where people can ask natural questions in their own languages and obtain short, precise answers, one of the main shortcomings of existing search technologies.

Learning the lessons of the past

Such hurdles, while negotiable for the majority of people, do not allow for truly efficient technology usage, a goal very much in the interest of both commercial and individual users. Hence the development of the Qall Me project which, with the overall goal of establishing a shared infrastructure for multi-lingual and multi-modal open domain question answering for mobile phones, represents a focused, collective effort to advance QA research and technology.

This is an area where project leaders are confident their initiative can bring significant improvements. “QA, in the way that it is currently being addressed by the research community, still lacks a number of crucial ingredients,” they outline.

“Among these ingredients, we believe that the capacity of the system to learn from previous interactions, the awareness of contextual information, like place and time, and the ability to bring QA closer to the user, like on mobile cells, are all factors that are going to be crucial to a concrete technological deployment.”

This kind of broad-based approach leaves the project well-placed to avoid the pitfalls of the so-called ‘information explosion’ where, if anything, Internet searches return too much information. In this context developing a user-centric, context-aware approach is crucial, something that requires the initiative to take a diverse range of considerations into account. “In the Qall Me project, we want to investigate new methods and technologies that can help to put more ‘understanding efforts’ on the machine’s side. On the ‘document’ side (i.e., on the machine side) the Qall Me technology will return exact answers to questions, e.g., a small set of relevant documents, a single document or the exact text passage that answers a particular question,” says Orasan.

“In doing so the Qall Me engine will take into account the time and spatial context of the user (e.g., through GPS) as well as his current domain of interest (e.g., through domain ontologies). In this way, the Qall Me engine will be able to adapt to the user’s communication context and situation.

Our technology will enable a user to express an information request using natural language questions like ‘When will BMW offer its new model to the market?’ that is more natural and more effective than using ‘BMW offer new model market’.”

Natural language

Allowing users to express their own information needs without needing to modify their language to suit the technology will bring significant benefits. Indeed, not only can users be confident that the technology will be capable of identifying the context and meaning of their particular search, but the Qall Me approach is not limited merely to the area of written input either.

“Users will be able to more easily express their precise information needs, while the semantic-based content providing services will be able to more precisely identify and extract the relevant answers and also take into account the meaning of the user's request,” continues Neumann. “The Qall Me user interface...
At a glance

Full Project Title
Question Answering Learning technologies in a multilingual and multimodal Environment (QALL-ME)

Project Objectives
Qall-Me aims to develop a web-based architecture for cross-language QA

Project Partners
DFKI, Research Lab, Germany
University of Alicante, Spain
University of Wolverhampton, UK
Comdata S.p.A., Italy
Ubiest S.p.A., Italy
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Our technology will enable a user to express an information request using natural language questions like 'When will BMW offer its new model to the market?' that is more natural and more effective than using 'BMW offer new model market'
Simulating the two way dynamics of norm innovation

The creation of the Internet and digital connectivity has given rise to large self-organising people networks and social structures, which have developed into massive target-oriented communities which facilitate production processes, making possible concepts such as Open Source development and distribution. How these organisations create social structure and social behavioural norms is a subject being investigated by the EMIL project. Understanding this unprecedented ‘architecture of participation’ is important to unravel the new social paradigms, outside our usual modes of hierarchy and interaction, by which we can develop products and services.

Open source is a particularly relevant example of this new emergent model of self-organisation. For instance, it lacks the normal market based governance systems and the normal methods of command and control. The evidence makes it clear that the mechanisms upon which Open Source relies were not pre-conceived but instead have been discovered through

There have been few attempts to identify the defining characteristics of e-community based social systems and yet infrastructures emerge with their own behavioural norms. Rosaria Conte of the EMIL project seeks to understand and design strategies around the dynamics of sociality.
practice and are still ‘in process’. Understanding the intricacies of this social model are important and as yet, little understood. The model shows us that a collection of small local contributions can be harnessed to deal effectively with large scale global problems. We must investigate how it is possible for the loosely orchestrated contribution of hundreds or even thousands of actors to self-organise in order to generate a solution to some target issue or problem?

Project aims
The prime objective of the EMIL project is to understand and develop design strategies able to cope with the complex two-way dynamics of sociality, consisting of emergent and immergent processes: from interaction among individual agents to aggregate level, and immergence of entities (norms) at the aggregate level into agents’ minds – specifically EMIL plans to look into norm innovation. A theory of social order must be bi-directional and it must show how innovative phenomena (e.g., institutions) affect the social systems they emerge from.

The research will deal with many facets of this social discourse, from dealing with resulting issues such as incompleteness and uncertainty, and to contribute to the understanding and description of hierarchic systems by describing agents acting on multiple levels, i.e. individual, communitarian and institutional.

Another aim of the project is to try and understand the distributed processes in IT in this context. Therefore the project is planning to model the interactive, bi-directional processes of emergence.

With these aims in mind, there are specific questions that the project is attempting to find answers for. They include the following:

- Which are the factors (both inter and intra agent) that give birth to the emergence and diffusion of new conventions in a complex society (by convention, essentially meaning a behavioural regularity observed in a given population at a given time)?
- Which are the conditions that favour the stabilisation of new conventions?
- What is the difference, if any, between a convention and a norm? Intuitively, a norm is a legitimate prescription. What are the objectives and immergent correspondents of this notion and how do you operationalise it?
- How do new norms relate to existing ones? More generally, what is the relationship between new norms and the context in which norm innovation takes place?
- Finally, when and why does a norm become useless and/or non-prescriptive, when does it decay and eventually disappear?
Constructing a simulator
Whilst the theoretical aims are to understand and manage these complex social systems, and to work out how new conventions and norms emerge in these systems the main technological aim is the construction of a simulator for exploring and experimenting upon norm-innovation.

On this more practical side, the project is expected to contribute to the regulation of e-communities by handing out the simulator for the emergence of new norms.

The prime objective of the EMIL project is to understand and develop design strategies able to cope with the complex two-way dynamics of sociality in complex social systems, where experiments can be run. While the simulator will be designed as a general-purpose tool, some specific study cases will be selected to provide the necessary grounding parameters.

Research on the construction of interacting artificial cognitive agents is not a exactly a new area, but current systems lack the scalability necessary for large scale modelling. This is why the main technological aim of the project is the construction of a system that is capable of performing norm innovation at the appropriate scale.

In order to build this system there will be a need to develop a platform for the simulation of cognitive agents using appropriate Open Source and readily available technologies and integrate simulations on different agent levels (e.g. agent, institution and society), modelling the interplay among different levels in norm innovation. There will also be a need to integrate data acquisition and modelling, by taking into account data from simulation while modelling and building the simulator.

The selected field of application will be the rise of collaborative community norms in the Open Source community where new conventions have establish and new norms are being invoked. The stabilisation of both is a major concern in this community, which offers (a) an interesting observatory of the mechanisms and processes of norm innovation, (b) an appropriate environment from which to draw essential data to be fed into the EMIL Model (EMIL-M) and Simulator (EMIL-S), and (c) an application field for testing its utility.

a. Chromatic representations of the actions generated by the Social Conformers. At each colour corresponds a different action: the blue colour represents the action common to the 4 scenarios; on axis X we find the number of agents (100) and on axis Y the number of simulation ticks (100). b. Chromatic representation of the actions generated by the Norm Recognizers.

At a glance
Full Project Title
EMIL, EMergence In the Loop:
Simulating the two way dynamics of norm innovation

EC funded project (Sixth Framework Programme – Information Society and Technologies – Citizens and Governance in the Knowledge Based Society)

Project Partners
- Institute of Cognitive Science and Technology, National Research Council CNR-ISTC Italy
- University of Bayreuth, Dept. of Philosophy UBT Germany
- University of Surrey, Centre for Research on Social Simulation UNIS United Kingdom
- Universität Koblenz-Landau KL Germany
- Manchester Metropolitan University, Centre for Policy Modelling MMU United Kingdom
- AITIA International Informatics Inc. AITIA Hungary

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Rosaria Conte
Head of the LABSS (Laboratory of Agent Based Social Simulation)

Rosaria Conte is head of the LABSS (Laboratory of Agent Based Social Simulation) at the ISTC (Institute for Cognitive Science and Technology), and teaches Social Psychology at the Univ. of Siena.
She is a cognitive and social scientist, with a special interest for the study of positive social action (altruism, cooperation and social norms), and reputation-based social regulation. She is coordinator of both European and Italian research projects.
Getting a grip on product design with SATIN

What is perceived to be ‘good design’ emerges from a number of factors. Useability, durability, usefulness and the all-important ‘wow’ factor are only a handful of issues consumers take into consideration when choosing to buy a new product. The look, the feel and the overall aesthetics of the item are as equally important, and designers constantly strive for higher standards in these fields in order to make their item a ‘must-have’ object.

Incorporating the sense of touch into an object is seemingly at odds with a design culture that is almost entirely consumed by computer-based design. There is a danger that designers become out of touch, so to speak, with how an object feels. That all might change with the Sound and Tangible Interfaces for Novel product design (SATIN) project. SATIN, led by project officer Philippe Gelin, is developing a system based around a tape metaphor that mimics an industrial clay modelling process where the tape can be used to evaluate and modify the shape of an object (e.g. a car body or a glass object).

The research project is funded by the ‘Multimodal Interfaces’ area of the European Union’s research funding programme (FP6-IST) and aims to develop a novel multimodal interface to support designers in evaluating and modifying virtual design prototypes. The system is multimodal because it allows users to perceive and evaluate a virtual object shape along a curve by interacting with a haptic strip, looking at the stereoscopic visualisation of the object and also hearing as sound the geometric characteristics of the shape.

The key challenge of the SATIN project is to give access to sophisticated geometric modelling and computer graphics tools to certain types of creative people not currently working exclusively with computers. Using the SATIN prototype it is hoped that their creativity, mainly based on craftsmanship and manual skills, will be able to be exploited.

Motivation
The context of use of SATIN is the design review of newly conceived products. In the process of creating new shapes, designers often need to touch the surfaces...
of their products to check and evaluate their aesthetic quality. The ability to touch and feel the objects they produce during the design process allows designers to better evaluate their shape in terms of their geometric properties. Physical objects – commonly named physical prototypes – can be built directly or starting from a computer generated digital model.

Although physical prototypes are a good means for product evaluation, they also show some limitations; for example, they do not allow variants of shape and material, and don't support easy shape modification and immediate correlation with the corresponding digital model. In addition, the production of the physical prototype is costly and time consuming, especially in respect to the other product design phases. The SATIN project aims at eliminating the necessity of building physical prototypes by integrating into digital design tools the possibility of physically touching the virtual prototypes.

The SATIN system consists of an Augmented Reality environment where the user can interact with virtual 3D objects. The user is able to see the object and to both explore and modify the shape of the object through the use of touch. The SATIN system consists of a haptic strip that mimics the tape placed by designers on physical mock-ups for evaluating characteristics and style lines. In addition, a 3D visualisation of the shape is super-imposed onto the physical device by means of a stereoscopic rear-projection system. An important and innovative element of the project lies in the use of sound as a means to convey information and feedback about the virtual object and the user interaction. Specifically, the use of sound allows the designer to explore geometric properties of the object that are not detectable by touch or sight.

**Innovative aspects**

The innovative aspects of SATIN are several:

- The haptic strip is a tool of new generation that allows users to perceive the continuous curvature of smooth shapes and also modify them
- The haptic strip is a major, state-of-the-art advance in the domain of haptics since the device would be the first to propose a continuous physical contact along a line
- Sonification is an innovative way of conveying information about curves that has never been used in modelling before
- The system architecture accommodating a co-location of stereo vision and large haptic working space is new
- The system architecture is distributed and handles and synchronises processes for modelling, visualisation, haptic rendering and sonification

In short, the SATIN system is a tool of new generation where the product shape creation and evaluation is based on a manual approach. This is expected to have a strong impact on product design and the product development process.

**Scientific target**

The scientific goal of the project consists of integrating several scientific and technical domains including geometric modelling, computer graphics, sound and haptics into a unique and coherent system by addressing, solving and optimising complex problems related to synchronisation, interoperability and data fusion, then implementing a multimodal interface that is intuitive and easy to use for target users.
SATIN system
The system consists of a haptic interface, including two FCS-HapticMaster devices connected and integrated with a new haptic strip for shape evaluation and modification. The user can explore and evaluate a surface shape along a trajectory interactively defined by slipping her fingers on the haptic strip that takes the shape of the curve on the virtual model. The shape can be modified by exerting pressure on the haptic strip in single points, or by applying traction/compression and flexion/torsion at the ends of the strip.

The visualisation system is rear-projection based. The user wears stereoscopic glasses for 3D models viewing; her viewpoint is driven by an optical tracking system.

The virtual shape is precisely superimposed to and co-aligned with the haptic strip in order to mimic real life situations.

The user can explore and evaluate a surface shape along a trajectory interactively defined by slipping her fingers on the haptic strip that takes the shape of the curve on the virtual model

The system also provides metaphoric sounds related to geometric characteristics of the explored shape (curvature, discontinuities, etc.) and also provides feedback about the user’s actions (i.e., forces applied during shape manipulation).

Impact
The SATIN project addresses the wide market of industrial product design in Europe. The system will exhibit a new generation of design systems where the shape modelling functionalities, the haptic and tangible interfaces fused with sound and the human-computer interaction are completely new and innovative in respect to current available applications.

It is expected that the SATIN system would have a significant impact in the industrial design sectors and would improve knowledge, productivity and quality of designers’ working conditions. In addition, it will also improve the quality of product design by proposing hi-tech methods that preserve designers’ usual modus operandi. The new way of working that is made available by the project will enable a larger number of people to operate in the area of product design without the necessity of having specific competences in technical fields like maths and computer aided design tools.

The SATIN project constitutes a significant breakthrough with several side effects in the area of design tools. It is developing an innovative interface that supports a new way to create and modify shapes, and a new way to evaluate the surface through free-hand movements over the sensorised strip.

SATIN project results so far have influenced research in the area of haptic and tangible interfaces, implementing a haptic interface with a high number of degree-of-freedom and multiple parallel coordinated controls connecting the sensorised strip for free hand interaction with shapes.

SATIN also introduces and validates the new dimension of sound used for communicating geometrical characteristics of shapes, as well as for providing feedback of the user’s interaction with the shape.

Partners
The partners involved in SATIN come from different research areas including haptic systems, computer aided design tools, computer graphics and multimodal interaction, sound interfaces, cognitive psychology and industrial design. Technology providers involved in the project are MOOG-FCS developing the haptic technology, and think3, developing CAD tools. Industrial end-users include two Italian companies well-known world-wide for their exclusive design: Alessi and Italdesign-Giugiaro, and the Slovenian company Steklarna Hrastnik making glass products.

At a glance

Project Title
Sound And Tangible Interfaces for Novel product design (SATIN)

Project Partners
- Politecnico di Milano, Italy, Umberto Cugini
- think3, France, Alain Massabo
- MOOG-FCS, the Netherlands, Piet Lammertse
- INESC, Portugal, Manuel J. Fonseca
- Technische Universiteit Eindhoven, the Netherlands, Armin Kohlrausch
- University of Nottingham, UK, Sarah Sharples
- ALESSI, Italy, Cristiano Colosio
- Italdesign-Giugiaro, Italy, Luca Jozzo
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Monica Bordegoni
Full professor at the Faculty of Industrial Design

Monica Bordegoni is full professor at the Faculty of Industrial Design, Politecnico di Milano. She is coordinator of the Virtual Prototyping group. She is involved in several European and national research projects and she is the Coordinator of the SATIN project.
Global business competition is intense, and Europe must keep pace with technological change if it is to build upon its economic strength. Establishing close links between academia and commerce will ensure research advances lead to economic benefits, says Darren Morrant of EurExcel.

Innovating as a dynamic community with EurExcel

Commercial competition is growing increasingly intense in today’s globalised economy, and Europe can no longer rely on its established expertise and advanced infrastructures to ensure its long-term prosperity. This is something of which we at EurExcel (the European Association of Innovating SMEs), an organisation established in 2002 expressly to support innovative organisations, are keenly aware. In the knowledge that ongoing innovation and new products drive the European economy, EurExcel has developed an explicit commitment to helping European business to both capitalise on the potential offered by the global market for their products, and also to keeping them at the cutting edge of technological innovation. This latter aim involves ensuring that businesses on the continent benefit fully from the exciting work being undertaken by European research projects and establishing effective communication between the academic and commercial sectors.

It is EurExcel’s belief that many of the problems European Industry faces, in terms of both technology and understanding, either have a scientific solution or that somewhere there exists a uniquely qualified mind capable of providing the answers. Indeed, experience has led EurExcel to appreciate that their main challenge is to match solutions with problems and problems with solutions,
It is EurExcel's belief that many of the problems European Industry faces, in terms of both technology and understanding, either have a scientific solution or that somewhere there exists a uniquely qualified mind capable of providing the answers for problems, or a problem in need of a solution, is welcome to apply.

With the ability of European companies to develop innovative new products incorporating state-of-the-art technologies providing the continental economy with a real competitive advantage, there must be no lessening of our commitment to ongoing development if Europe is to maintain and build upon its established economic strength. EurExcel is closely involved with a number of projects addressing areas of crucial importance to technological development, three of which we will now look at in greater depth.

The Laboranova project
The Laboranova project, which is working to advance the area of collaborative tools, offers a prime example of just such an initiative. Existing collaborative working environments (CWEs), which focus mainly on supporting traditional working paradigms of linear workflows by providing IT-based platforms for planning, scheduling and executing tasks, are increasingly proving incapable of meeting commercial needs, meaning there is a clear need for a new generation of collaborative tools. If we are to achieve continuous strategic innovation, and thus establish a sustained competitive advantage for European businesses, then organisations need to increase their capacity for open-ended, non-linear problem solving involving a wide range of participants in knowledge-rich environments. This must be supported by the next generation CWEs which, in turn, require new paradigms to manage the knowledge transfer, social dynamics, and decision-making processes that form such a crucial element in the process of technological innovation.

The primary objective of the Laboranova project is thus to create this next generation of collaborative tools, tools which it is hoped will fundamentally change the existing infrastructures for technological and social collaboration. These tools will also support knowledge workers and e-Professionals and enable them to systematically share, improve and evaluate ideas across teams, companies and networks, further reinforcing their broad relevance to the development agenda. Laboranova's research is focused on developing and combining models and tools in three specific areas; ideation, connection and evaluation. These pillars will be leveraged by advanced game methodologies in order to improve collaborative work processes, work which will bring tangible benefits to industry. Indeed, by integrating these efforts, innovative collaboration approaches and organisational models for managing early innovation processes will be developed, while this work will also result in new software prototypes and the integration of models and tools into a collaborative innovation toolset. This will both change the way knowledge work is undertaken, and also increase the capacity of both companies and organisations to develop and build innovative new products.

The NanoHand project
Similarly the NanoHand project, although addressing a quite different topic to Laboranova, is also focused very much on addressing emerging needs and keeping Europe at the forefront of technological development – an objective EurExcel is actively pursuing. The project's goal of developing a system consisting of micro/nano based sub-systems for the automatic handling of nanometre-sized objects is a technically demanding one, and is largely being driven by the needs of semiconductor technology. This, in turn, is a technology which underpins a number of the consumer electronic devices that play such an important role in modern business and leisure, thus debunking the commonly-held view that research by projects like NanoHand is simply too advanced to find a practical application.

This wide potential is further reinforced by the fact that, in the pursuance of its...
At a glance

Company name
EurExcel - The European Association of Innovating SMEs

Objectives
Formed in 2002, EurExcel is a Pan European Trade Organisation, with offices in the UK and Belgium. They have significant experience in Framework Programme R&D and other social and support actions. Taking roles in the projects including dissemination, exploitation, training and management. EurExcel provide other services which include (amongst others) proposal writing, consortium formations and IPR surveys.

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Darren Morrant
Darren Morrant is a Prince 2 certified project manager with a track record of director level appointments and experience of government funding bodies. This has led neatly into the last four years during which he has worked as an Exploitation Manager on large European Union funded research and development projects at EurExcel.

Experience has given Darren the ability to recognise realistic commercial opportunities and to create matching business models, an ability crucial to the development of the European Innovation Exchange.

Project I3CON

The I3CON project, another initiative with which EurExcel is closely involved, is also focused on bringing tangible commercial benefits to its participants. I3CON will facilitate a general transformation towards a sustainable European construction industry by delivering industrially-produced integrated processes and intelligent building systems, using distributed control systems with embedded sensors, wireless connections, ambient user interfaces and autonomous controllers. New value-based business models, with highly specialised SMEs working in radically contracted supply chains, will deliver high performance spaces, smart business services and lifecycle solutions.

This objective-driven approach is very much in line with EurExcel’s overriding philosophy, and with I3CON working to develop a new approach for the industrialised production of building components with integrated services and intelligence, the project will bring radical change to the construction industry. These building components will be sustainable, multi-functional, efficient, reusable, interoperable and user friendly, while the underlying new business model will shift current working practices away from custom-designed and craft-made delivery towards industrial production. Europe’s capacity to innovate is central to its economic future, this is something of which we at EurExcel are very much aware, and which informs our work to build on existing research advances, and turn those advances into the innovative products of the future. ★

goals, NanoHand builds on, and enhances, existing research. The cornerstone of the NanoHand project is the results generated by the ROBOSEM project (Development of a Smart Nanorobot for Sensor-based Handling in a Scanning Electron Microscope), which developed and demonstrated the technological basis for micro-robotics. However, NanoHand’s goals go far beyond merely utilising these results to develop an industrially applicable, automated handling system for nano-objects and their applications. Rather, thanks to these micro-robotic techniques, new possibilities will be assessed in two particular industrial application methods:

1) the automated decoration of scanning probe microscope (SPM) probes
2) the handling and assembly of nanometre-sized objects for the construction of nano-electronic devices

The techniques and tools developed within the project for handling nano-objects and their applications will have a positive impact on those SMEs involved, and also equipment manufacturers and semiconductor industry end-users themselves.

NanoHand will push the limits of robots in terms of their accuracy, speed and ability to manufacture devices out of nano-tubes and nano-wires. Its main goal is to establish a foundation for a European micro-robotic industry in the area of handling nano-objects with different smart modular robot components. This will open up new market opportunities for innovative companies, thus encouraging them to use the project’s results in new and unexpected ways.
The future of software engineering for industry

Software engineering is an area of crucial importance to the global economy. With business growing ever-more dependent on advanced technologies, the commercial sector demands a correspondingly wide range of attributes from its software tools. As such the development of new methods of software engineering capable of adapting to emerging demands is a real priority, and the MODELPLEX (Modelling Solutions for Complex Software Systems) project, an EU-funded initiative working to develop an open solution for complex systems engineering, represents an important step towards this goal. “The idea of the MODELPLEX project is that we should address issues like the size, complexity and heterogeneity of software by further developing model-driven engineering (MDE) tools and methodologies,” says Wasif Gilani of SAP, the leader of MODELPLEX’s Work Package 1 (Industrial Cases). “We aim to develop methods that will be applicable for industrial users – and they have already provided us with some complex cases. We want to use these cases as an example so as to show that our method can actually handle issues like complexity – for example the different languages and environments that are involved in system development.”

Overcoming the limitations of MDE

In its short history MDE has proved itself to be an approach capable of both reducing the costs of software engineering and also improving its quality. Nevertheless, a number of shortcomings with the existing methods of MDE have been identified, encouraging those within the project to believe that the inherent attributes of MDE can be built on further. “Firstly, there is still a lack of proper tooling, especially for verification and testing,” points out Andrei Kirshin of IBM, the leader of Work Package 4 (Verification and Validation). “A number of different isolated tools supporting MDE already exist. B, but there is no integrated MDE platform for the whole lifecycle of the software development process. In MODELPLEX we are aiming to create just such an open platform so as to solve a number of different problems – such as interoperability, substitutability and traceability. The third shortcoming is the huge legacy costs. We have responded by developing prototypes of easy-to-use tools so as to improve both the quality of production systems and also the productivity of engineers.”

These kinds of tangible benefits greatly enhance the project’s prospects of ensuring the successful adoption of its technology by industry. This, one of the project’s stated aims, presents a particular challenge, as the commercial sector typically takes quite a hard-headed approach to new technologies. Nevertheless, Parastoo Mohagheghi of Sintef, the leader of MODELPLEX’s Work Package 3 (Model Engineering), is confident that the project’s approach will bring long-term benefits to software engineers. “At the moment models are developed mainly to aid understanding and many people programme using traditional languages. The problem with this approach is that software soon becomes quite difficult to understand,” she explains. “By using a model-driven approach you have everything you need in the models. It will be easier to keep updated, while the effective use of models will also make software easier to learn than a hand-written code. We can also provide technologies like traces between artefacts. This means that if you change something then you can automatically detect which other artefacts should be changed as well. This is an issue when you are performing maintenance. For example you might be changing software modules. As things stand you won’t know which other modules are affected by your change, this is an issue we want to address.”

These words hint at the relentless nature of development in the software engineering field, something that poses a real challenge to MODELPLEX. New software requirements emerge on a seemingly continual basis, a trend which places heavy demands on the project. However, these are demands to which MODELPLEX is responding. “Our work is about ensuring that a requirement is satisfied by a configuration of the system, and possibly reconfiguring the system at the time. This is what we call system management,” says Veronique Normand of Thales, the leader of Work Package 5 (Support, Management, Monitoring and Repair). “We are addressing types of systems where the design of these
systems is not statically defined at design time – it’s evolving. It can evolve, maybe because some resources have disappeared and you need to re-allocate resources, or some new requirements may emerge and you may need to adjust the system to fit those new requirements.”

This broad-based, holistic philosophy leaves MODELPLEX well-placed to address both current and emerging challenges. To illustrate, the project is also researching possible other ways in which architectural models of systems can be used, spanning a wide range of potential applications across the whole system lifecycle. “So far MDE research has focused on the design-time part of the lifecycle – what happens from the requirement and analysis stage until the design and implementation of the system,” explains Normand. “In this work package we are looking at what happens after that. Once the system has been implemented it is then deployed and starts running. However, while it runs some things can happen. For example, resources can go down or the traffic on the network can increase. If this happens then the time responses are not going to be the ones that were expected, which will have an impact on the level of availability of the different services provided by the system – which could in turn have a knock-on effect on the business. So we’ve got to analyse the impact of these different incidents to generate a comprehensive picture.”

With the first tools having appeared in the early ‘80s, MDE is far from being a new technology. However, the technology has developed beyond all recognition since, and while MODELPLEX of course builds on the advances achieved by previous initiatives – Modelware in particular – the project nevertheless also breaks significantly with its predecessors. This has, in turn, opened up new potential applications for MDE. “The pioneers of MDE were those who built complex systems such as aerospace, automotive, defence, telecommunications and embedded industries. This is where MDE is really critical and adds real value. It does this by providing a means to cope with the complexity of those systems,” outlines Kirshin. “In recent years it has expanded into different domains, such as consumer electronics. We aim to make sure that MODELPLEX solutions are capable of adapting to the particular demands of users. Industrial users will not get all the MODELPLEX products in one box. Users will choose a relevant sub-set of tools and will have to customise them to their specific context and domain. This is also part of MODELPLEX’s work. We work in close collaboration with industrial partners to address the complete needs of each particular partner.”

This approach leaves the project well-placed to fulfil their goal of ensuring the technology is widely adopted by the software engineering industry. Indeed, MODELPLEX has developed a comprehensive approach designed with the needs of end users very much at the forefront of their thinking. “What we are doing is gaining experience and developing tools for these complex cases,” says Mohagheghi. “We are doing this work so that companies can have an integrated platform that goes from developing models, to testing, right through to all the related areas. We provide a combination of tools – not just one single tool,” she continues, outlining the approach that the project has adopted in pursuit of further development.

Indeed, such are the benefits offered by MDE that Kirshin says it could eventually completely replace more well-established methods. “Even now, all software engineers use models in some form. I believe that in future, engineers will use models more often – and not only models, but also the methodologies, processes and tools for model-driven engineering,” he predicts. “I’m pretty certain that this transformation has passed the point of no return and that MDE is the method of the future,” agrees Normand. “There are a lot of barriers to be negotiated before we can develop mature, deployable industrial solutions, but they are barriers we are determined to overcome.”

I believe that in future, engineers will use models more often – and not only models, but also the methodologies, processes and tools for model-driven engineering.
In an ideal world, all buses would be wheelchair friendly and train timetables would be available in audio. Reality has yet to catch up with that vision, so instead European researchers have developed a personal navigation aid to help disabled people use public transport.

Helping disabled make use of public transport

By letting disabled people know in advance which bus routes, subway lines or rail links are disabled friendly, people with disabilities can plan journeys that they may otherwise be unable to make unassisted. Once on the move, location-based services accessed via a smart phone or handheld computer can highlight points of interest, warn them of potential obstacles and let them change their itinerary as needs be.

“Until you meet with disabled people and talk to them about their needs it is hard to imagine just how difficult using public transport is,” notes Gary Randall, a researcher at BMT in the United Kingdom. “They are scared of finding themselves isolated, of being abandoned in the world.”

Someone confined to a wheelchair, for example, may end up stuck at a bus stop many kilometres from home if a bus with wheelchair access never arrives, or a blind person could easily become lost trying to make a train connection if there is no one to assist him or her. For that reason, few disabled people use public transport alone in what constitutes a severe restriction of their freedom and autonomy.

To address that problem, researchers working in the EU-funded MAPPED project developed personal navigation software designed specifically to meet the needs of people with disabilities. The system extends technology used in now commonplace GPS navigation aids. It incorporates information about public transport timetables and routes as well as so-called points of interest to disabled people in what the researchers describe as the first application of its kind.

“A point of interest for someone with a disability is often very different from what [it] would be for you or me,” says Randall, who coordinated the initiative. He notes, for example, that someone with limited mobility would want to know if a building has an elevator or if you have to go up steps to enter a restaurant, while a blind person would find it useful to know in advance if a certain supermarket has someone available to help with their shopping. That information is obtained wirelessly from a preloaded database. The data is then presented to the user in a variety of formats tailored to their individual needs, including visual maps and audio instructions.

“Curiously, despite the wide variety of disabilities, we found that the needs of different groups of test users were very similar regardless of whether they were in a wheelchair, visually impaired or had hearing disabilities,” Randall says. “They all want the reassurance that having a personal navigation aid can provide.”

In trials in Dublin and in Winchester in the United Kingdom, people with different types of disabilities tested different versions of the system. Their reactions were generally positive, with 84 per cent saying they would find a route planner such as that developed in MAPPED useful in their daily lives.

Nonetheless, the trials identified several challenges that must be overcome before such a system goes into commercial use.

Users tended to find the off-the-shelf PDA on which the software was installed difficult to use because of its small buttons and screen, while the accuracy and reliability of the GPS information needs to be improved to make micro-level route planning effective. New mobile devices with better user interfaces and incorporating digital compasses, coupled with the roll-out of Europe’s more accurate Galileo positioning system should solve those problems over the coming years.

“Usability and reliability are obviously crucial,” Randall says.

An even bigger problem, however, may be gathering the information about public transport routes, timetables and, especially, the accessibility features of museums, restaurants, shops and other points of interest.

“For the trials, we had to go around and visit restaurants and cinemas individually to see what their accesses were like – that is evidently not a practical solution,” Randall notes.

Instead, the researchers have considered allowing users to add their own content or working with business directories to obtain the information.

In light of the challenges, Randall believes public-sector support will be essential if a navigation aid such as that developed in MAPPED, which was funded under the EU’s Sixth Framework Programme, is to be widely used.

In that vein, he foresees the system or elements of it being deployed in different European cities where local governments have the political will to make location-based services for disabled people, tourists and other users available. ★

Source: www.alphagalileo.org
InterLink enables research collaborations in ICT

Established with an explicit mission to foster and encourage collaboration between the commercial and academic sectors, the European Research Consortium for Informatics and Mathematics (ERCIM) is at the forefront of efforts to advance scientific research on the continent. This mission involves providing both administrative and logistical support to collaborative initiatives, and the InterLink (International Cooperation Activities in Future and Emerging Information and Communication Technologies – ICTs) project, of which ERCIM is the administrative coordinator, provides a prime example of just how crucial such initiatives are to Europe’s future.

“InterLink aims to advance Europe’s knowledge in a number of critical research areas in ICT, to promote European solutions and knowledge world-wide, and to influence the way research in these areas will evolve internationally,” says Constantine Stephanidis, Director of ICS-FORTH and Scientific Coordinator of InterLink. “InterLink supports coordination actions that will enable the European research community to interact with research communities outside Europe in a series of strategic research areas related to ICT,” he continues. “This will provide the means and support mechanisms to link European research communities to the best research carried out in other developed countries in these areas.”

This need to establish strong communication mechanisms to further the development of ICT technology is widely recognised. Indeed, as the contemporary society progressively becomes more global, so the need for efficient international collaboration grows more acute. These are the very issues that InterLink was formed to address, focusing on three key areas – software intensive systems and new computing paradigms, ambient computing and communication environments, and intelligent and cognitive systems.

Software intensive systems is a complex domain of investigation. As Stephanidis explains “The continuing decrease in the size and cost of microprocessors and storage devices is leading to the development of increasingly distributed and decentralised systems. In the near future, novel technologies will allow the construction of systems with millions of nodes, and systems will be likely to contain sub-systems based on novel computing paradigms, such as quantum computing. It is therefore imperative that we develop both fundamental principles and engineering techniques to reliably design, develop and deploy such systems.”

The technical challenges posed by the above evolution are dependent on progress in many relevant domains, which include the engineering of devices that function as nodes in software-intensive systems, the effective management of content, and...
interoperability and interaction between systems. “Intensive research into the specific problems faced by each of these domains is conducted by the InterLink Working Group on Software Intensive Systems and New Computing Paradigms, led by Prof. Martin Wirsing of the University of Munich in Germany,” says Stephanidis, before moving on to what he sees as a particularly crucial issue faced by the new generation of software-intensive systems – security. “The increasing distribution of systems leads to several security issues which are currently not sufficiently well understood,” he warns. “One such problem is the security of protected data in environments with non-trusted components. Furthermore, identity management and access control become much harder with increased distribution and network connectivity. Solutions do exist (e.g. hardware-based, single sign-on, etc), but they certainly need to be further advanced.”

Meanwhile, the changing nature of computer components is having a significant impact on software systems. “The complexity of the next generation of highly-distributed, component-based systems is driving the development of new engineering methodologies,” explains Stephanidis.

“These methodologies are expected to generate new process models for systems and software engineering, as well as new approaches for dealing with the distributed nature and the heterogeneity of those components invariably found in systems. The growing complexity of today’s systems cannot be handled without adequate languages to express requirements, design and implementation. We need new engineering techniques to develop more resilient systems – which can adapt to unforeseen circumstances – and also techniques to control emerging behaviour.”

Clearly, much remains to be done before Europe can call itself a true ‘knowledge society’. This vision is only likely to be realised when knowledge itself can be generated from information, and can then, in turn, be employed for knowledge-intensive tasks, something which Stephanidis believes involves the pursuit of several subsidiary objectives.

“Personalisation is one of the goals that must be attained if we are to provide IT services that improve quality of work and life,” he says. “The development and delivery of personalised services is imperative if we are to relieve service consumers from the arduous task of filtering out large volumes of irrelevant or inappropriate information that was retrieved as a result of their request. Similarly, different people have different needs, capacities and requirements. As such technology must proactively meet their knowledge, information or other needs.”

This is a goal being actively pursued by InterLink. Indeed, Stephanidis says that the
project’s work in the area of pervasive computing – focused on the ubiquitous provisioning of personalised IT services – has enormous potential. “The vision is to allow seamless, pervasive interaction with digital information by manipulating physical real-world artefacts as graspable, multi-modal interfaces, which can be achieved by taking semantics and context into account,” outlines Stephanidis. “In the next generation of highly distributed, autonomous, intelligent and ambient systems, we will witness networked societies of artefacts that are coordinated, self-managed, social model-driven and goal-oriented. They will be capable of proactively and interactively meeting user needs, but also self-configuring, self-healing, self-optimising and self-protective. Achieving this human-computer confluence will lead to invisible, implicit interaction between humans and devices, with the ultimate goal of improving quality of life. These are some of the topics that are currently under exploration in InterLink within the Ambient Intelligence Working Group, led by Dr. rer.nat. Dr.phil. Norbert Streitz of Fraunhofer IPSI, Germany”.

Much progress has also been achieved in the area of developing artificial intelligent cognitive systems, but transferability of the developed skills and abilities to varying contexts without costly redesign of specific solutions is still not possible.

“Research on cognitive systems will contribute significantly to the understanding of the human brain as it is the driving paradigm for the development of intelligent cognitive robots and new technologies. Additionally, this research will give rise to numerous important applications that span a wide range of areas such as space exploration, industrial environments and domestic assistance.” In the area of cognitive systems, Stephanidis says, “One of the objectives is to identify future research directions and to address fundamental questions related to the definition of cognitive systems, models of cognition and enabling technologies from the point of view of both natural and technical systems.

This will provide an opportunity to realize a fruitful cross-fertilization, giving technically oriented scientists new inspiration from biology, while opening to cognitive scientist’s new ways to prove and evaluate their models.

The InterLink Working Group on Intelligent and Cognitive Systems, led by Prof. Ruediger Dillmann of the University of Karlsruhe, Germany, is developing a relevant roadmap for research and exploring possibilities for international cooperation in this interdisciplinary research area”.

In the near future, the emergence of Software Intensive Systems and New Computing Paradigms, Ambient Computing and Communication Environments, and Intelligent and Cognitive Systems, will profoundly change the technological landscape and will play an important role in shaping contemporary society

While the project is working towards the elaboration of international research roadmaps, wider societal implications are also considered. “It is anticipated that this work will have a significant impact at an industrial level, and indeed industry representatives are directly involved in this project so as to provide an industrial perspective on the issues at stake,” says Stephanidis.

“The Information Society is gradually becoming a reality and is radically changing European citizens’ way of life. Technological change in ICT is very rapid, and everyday life is growing ever-more closely intertwined with the surrounding intelligent computing environment.

In this context, with technology playing an increasingly important role in shaping contemporary society, it is of paramount importance to the success of new ICTs that they are developed in such a way as to really improve the quality of life of citizens, and to be ultimately accepted by all people – regardless of whether they are expert computer users or not.

At a glance

Project Title
Coordination Action InterLink “International Cooperation Activities in Future and Emerging ICTs” (Contract No. 034051).

Objectives
InterLink aims at advancing Europe’s knowledge in a number of critical research areas, at promoting European solutions and knowledge world-wide and at influencing the way research in these areas will evolve internationally. Towards these goals, InterLink supports coordination actions that will enable the European research community to interact with research communities outside Europe in a series of strategic, basic research areas related to Information and Communication Technologies (ICT), and provides the means and support mechanisms to link European research communities to the best research carried out in other developed countries in these areas.

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Constantine Stephanidis

Constantine Stephanidis, Professor at the Department of Computer Science of the University of Crete, is the Director of the Institute of Computer Science – FORTH. Over the past 25 years, he served as the Scientific Responsible in more than 40 funded projects and has published more than 350 papers.
Europe's telecommunications markets have grown exponentially in recent years whilst in parallel, new Internet services emerge on a daily basis. The two areas are now converging and whilst presenting challenges this ultimately means a new and exciting environment for the telecommunications industry according to OPUCE (Open Platform for User-Centric service Creation and Execution) European project manager, Alberto Leon.

OPUCE aims to create a unique services environment via User Generated Services, enabling telecommunication devices like your everyday mobile phone to perform a wide and rich variety of different functions, many akin to Internet services. The communications market is overlapping with the Internet market, that much is clear. Instant messaging, Web 2.0, VOIP compete against, entangle and compliment SMS and mobile telephony. Communications is an increasingly complex area for industry which demands even more complex solutions.

“Communication markets are facing a challenging situation, as Internet competitors become a constant threat to Telco operator’s competences such as SMS and phone calls, focusing their efforts on clear market opportunities, in order to develop new convergent services,” says Alberto Leon.

Not only is the technology itself changing, but also the way users behave is constantly evolving.

“Web 2.0 users are no longer passive users who just receive information, in many cases they also want to participate. An Internet democracy is developing,” Leon outlines. “We thus have to adopt some changes in customer insights and give those pro-active users – let’s call them ‘pro-sumers’, those who want not only to consume, but to create – the channels and tools they need, to make the services market grow”, he continues.

Such challenges demand an outstanding technical expertise, hence the development of the OPUCE project, lead by Telefónica I+D and participated by R&D branches of Europe's foremost telecommunications operators and vendors, plus SMEs and academia.

OPUCE aims to develop a User Generated Services (UGS) platform prototype. Leon points out, “OPUCE provides an open service environment where end-users and third parties can fast create innovative services and use them in an easy and highly personalised way, without the need to maintain a service portfolio. The users themselves will dynamically create, personalise, share, provision and enjoy them. This will definitely improve user's experience, satisfaction and foster new business models.”

To achieve this goal, a highly versatile system for the user is required. “Nowadays on the Internet, users are generating their own content which they share. They write blogs, make photos, music and videos. OPUCE aims at developing a platform through which users can intuitively generate their own internet and telecommunications combined services intuitively. Users should not notice the complexity involved of the underlying network infrastructure or the device on which the service will be used,” explains Leon. Despite there being several so called ‘web mash-up’ (a web application that combines data from many sources into a single integrated tool) solutions available, Leon is confident that OPUCE will bring significant unique improvements.

“OPUCE definitely enhances typical mash-up tools with Telco-specific services support, including Telco resources provisioning, delivery and management mechanisms, which are much more complex systems than pure Internet platforms. Existing mash-up solutions have strong drawbacks, as most of them are just focused on web capabilities with a limited application, even unsuitable for professional usage, or require advanced ICT skills to be used effectively”.

User-centricity: from usability to user experience

The OPUCE project’s focus on UGS stands on a real evolution of the communications market, with a friendly approach to the last technological advances. While high levels of programming skills were previously a prerequisite for users wishing to customise innovative services, this project brings this into the realm of a far wider user base. “OPUCE wants to be useful, desirable, accessible, credible, findable, and of course, valuable” emphasises Leon.

OPUCE will bring benefits to customers...
as well as SMEs, vendors and Telco companies. Customers can now easily create a combined internet and telecommunications service according to their needs and share that with friends.

Leon said, “We have made a huge effort to develop these tools from the user’s perspective, involving real end-users in several project phases to get their direct feedback on our work, complemented by users’ experience tests. The result is a set of smart, graphical and friendly tools that engage and interact with the users.” Telecom operators no longer have to guess which services are good for their customers and dedicate a lot of efforts to developing and marketing these services.

An open approach is a must for OPUCE, to ensure that their tools meet the needs of users. “The philosophy behind Web 2.0 offers a very attractive choice for the telecommunications operators, as it capitalises on the collective intelligence of the user community, to create new knowledge and value for interactivity and social networking,” explains Leon. “OPUCE is user-centric and already adopts the open, forward-thinking innovation model, perfectly aligned with the Web 2.0 user-driven one. It can accommodate open business models, allowing third parties to provide their own services, regardless of the underlying technological complexity, in a reliable and robust way. User’s privacy and security are also a must.”

**User Generated Services (UGS) paradigm**

The ICT sector is evolving rapidly, and the UGS potential is huge. “OPUCE embraces Internet and Telco state-of-the-art, making communications services converge, paving the way to an evolution of business models,” says Leon. “Indeed, OPUCE offers several benefits to all actors of the Internet/Telco services value chain, also letting third party service providers like SMEs offer specific services, entering the telecommunication market by ad-hoc cooperation with other business players, and without deploying their own infrastructure.” OPUCE offers service providers a chance to build a pay-per-use base and composed services, and to have a potential service incubator.

At the end of the day it is the user who will benefit the most from the new tools, and it is the user who will be empowered by OPUCE, Leon acknowledges. “The end user will take control of the full converged, customised service lifecycle. OPUCE is providing tools for all phases of the service life cycle giving an unprecedented, although controlled, power to end-users to create and tailor services to their needs and share them in a community, increasing significantly the users satisfaction and experience. This paradigm introduces a variety of challenges on the underlying resources, as services need to be consistent, run safely and the network must be protected. ”

**OPUCE UGS Web and Mobile Editors**

**At a glance**

**Project Title**

OPUCE (Open Platform for User-centric service Creation and Execution)

6th Framework Program European project of the EC DG INFSO Software and Services Unit

**Project Partners**


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**Innovation Projects Manager**

Alberto León Martín has worked as Innovation Projects Manager in the New Services over Next Generation Networks division at Telefónica I+D, since 2002. He is a key international innovation expert and business development contributor and has worked across Latin America and Europe for Telefónica’s main business units. He has served as the technical leader of the Telefónica Internet IP network deployments, following investments and related activities of the Group, with an exponential growth in those regions. OPUCE will be at the ICT’08 event. (stand H-04)
Ralf Schäfer, Head of the Image Processing Department, Fraunhofer Heinrich-Hertz-Institut, Berlin, describes research and development in 3D video, which, due to industry’s commitment will have significant impact on both Communications and Entertainment, for the world of tomorrow.

3D Video – Amazing New Technologies for Tomorrow

3D-Video enables new immersive application such as 3DTV, 3D movies, immersive events, surround video, public 3D theatres, and new forms of immersive video communication. Especially recent advances in 3D display technology and Hollywood’s commitment to produce 3D content have stimulated R&D as well as standardisation initiatives in this area. Therefore Fraunhofer HHI has concentrated substantial resources in 3D research and is involved in nine related projects, of which four will be presented in this article.

The entertainment industry is growing worldwide with rates between 5 per cent and 20 per cent. Even higher growth rates can be observed in the area of 3D cinema. In 2006, 330 3D screens had been installed in the US. In 2007 this number had increased to 768, and in 2008 it has doubled. By 2011 more than 4,300 3D screens are expected to be up and running. The same growth is seen for 3D film production, with a number of Hollywood studios announcing major productions in 3D.

These developments have of course an influence on the home market, because secondary distribution (DVD, Blu-ray) of movies has become an important market segment. In addition recent advances in 3D display technology have stimulated research and development in this area and several consortia have been founded and standardisation activities have been initiated. Back in 2003 a large-scale 3D Consortium with 70 partner organisations was founded in Japan and more recently three new major activities in this area have been started, including:

- The 3D Home Consortium (http://www.3dathome.org/) with partners like Philips, Samsung, Disney, 3ality, IMAX, In-Three, DDD, Thomson, SENSIO, SeeReal and Fraunhofer HHI is dedicated to facilitate the development of industry standards and their dissemination, to create and publish useful technical roadmaps and to develop educational materials for training, consumer and retail channels.

- The SMPTE 3-D Home Entertainment Task Force, which shall define the parameters of a stereoscopic 3-D mastering standards for content, to be viewed in the home.

- The Rapporteur Group on 3DTV of ITU-R Study Group 6, which shall define the requirements for 3D terminals and work on quality assessment of 3D systems.

In addition, the Moving Pictures Experts Group (MPEG) of ISO/IEC is working on a new coding format for 3D video.

Requirements for future 3D video systems

The introduction of a new media service requires the development of a complete chain for production, postproduction, transmission, reception and display. The ultimate goal is the development of systems which do not use glasses, i.e. uses autostereoscopic displays. This is technologically very challenging, because it requires a 3D format, which allows the generation of N (where N can be as high as 40 or more) views without loss in quality.
Therefore depth information and further metadata are required for postproduction, transmission and rendering in the terminal. This side information is today generated in manually supported processes but has to become fully automatic in a future system.

Fig. 1 (see overleaf) shows an example of a possible distribution format, which is composed of three views with associated depth maps. In the terminal, which uses eight views in the given example, a corresponding view conversion by using techniques such as ‘image based rendering’ has to take place.

3D projects at HHI

Stimulated by the excellent market expectations, the numerous international activities and the advances in 3D display technology, HHI has decided to put substantial resources for R&D into 3D video, in order to become a global competence centre in this area. In addition HHI is participating in the four international (standardisation) committees mentioned above. Altogether HHI is involved in nine collaborative projects out of this area, of which seven are funded by the EU (FP6, FP7), one by the German Ministry for Economy and Technology (BMWi) and one by the Fraunhofer Society. Four of these projects – which started in 2008 and will last for 30 to 48 months – are presented here.

By 2011 more than 4,300 3D screens are expected to be up and running. The same growth is seen for 3D film production, with a number of Hollywood studios announcing major productions in 3D

PRIME

PRIME is a German project funded by BMWi with the eight partners. The objective is to investigate the complete 3D food chain from the camera to the display, but concentrating on production tools and procedures, postproduction and transmission formats. Novel application fields such as 3D cinema, 3DTV and 3D games will be addressed and in addition market studies will be performed. There are four main work packages, i.e. acquisition, postproduction, presentation and market analysis & business models. In addition quality assessment and acceptance testing will be performed and a demonstrator will be implemented.

To research and develop practical networked technologies for the capture, production, and display of sounds and images in three dimensions

To create a heightened sense of presence, putting the spectator at the heart of the experience

To develop means of navigating a virtualised world, based on captured data, that has a complete sense of reality

To develop means of changing things in this world once it has been created

To make it possible to repurpose and deploy multi-dimensional content in different contexts

3D4YOU

The 3D4YOU project develops the key elements of a practical 3D television system, and it will define a 3D delivery standard and a content creation process. It will develop multiview and depth capture techniques, convert captured content for broadcasting and develop 3D coding for delivery via broadcast or IP networks. An important output of the project will be the definition of a 3D delivery standard that is independent of display technology, and backwards compatible to 2D broadcasting as shown in Fig. 2 (overleaf).

With this work it aims to pave the way to the definition of a 3D TV system suitable for a series of applications. Different parameters can be set depending on the application, but the basic technologies will maintain as much commonality as possible to favour the emergence of an industry based on those technologies.

The main objectives of the project are therefore:

• To research and develop practical networked technologies for the capture, production, and display of sounds and images in three dimensions

• To create a heightened sense of presence, putting the spectator at the heart of the experience

• To develop means of navigating a virtualised world, based on captured data, that has a complete sense of reality

• To develop means of changing things in this world once it has been created

• To make it possible to repurpose and deploy multi-dimensional content in different contexts

2020 3DMEDIA

2020 3DMEDIA is an integrated project of the FP7 programme. Its goal is to research and develop technologies to support the acquisition, coding, editing, networked distribution, and display of stereoscopic and immersive audiovisual content to provide novel forms of compelling entertainment experience in the home or public spaces. The users of the resulting technologies will be media industry professionals across the current film, TV and ‘new media’ sectors to make programme material addressing the general public. There are five main scientific and technical objectives:

• To deliver an end-to-end system for 3D high quality media
At a glance

Project Title
Fraunhofer project: 3DTV
– Television of the future

EU Projects
3D4YOU (STREP, FP7), 2020 3DMedia (IP, FP7), 3D-Presence (STREP, FP7), Mobile 3DTV (STREP, FP7), 3D PHONE (STREP, FP7), MUTED (STREP, FP6), 3DTV (NoE, FP6)
BMWi project: PRIME

Project Information
The Image Processing Department of Fraunhofer HHI in Berlin is researching and developing multimedia systems and applications. Key areas are video coding and transmission, computer vision and graphics, immersive video systems including 3D film and 3DTV, and hardware/software solutions for multimedia. 3D video is one of the most important strategic topics and HHI is involved in 9 collaborative projects in this area funded by the European commission, the German Ministry for Economy and Technology (BMWi) and the Fraunhofer Society.

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Dr. Ralf Schäfer
Head of Image Processing Department

Ralf Schäfer received his Dipl.-Ing. and Dr.-Ing. degrees both in electrical engineering from the Technical University of Berlin in 1977 and 1984 respectively. In October 1977 he joined the Heinrich-Hertz-Institut (HHI) in Berlin. Since 1989 he is head of the Image Processing Department. In the department he is responsible for about 50 researchers and technicians, about 30 students and currently 25 R&D projects.
Quantum computing with nanoscale infrastructure

It is clear that if the miniaturisation of microelectronic chips continues for another 10 years, following Moore’s Law of exponential advancement, then eventually the active components will be the size of atoms and molecules. Quantum physics rules the world of atoms and molecules and so the obvious conclusion is that future computers will be quantum computers, right? Well, it is not quite that easy, but the notion is quite suggestive.

In December 1959, Richard Feynman, American physicist and pioneer in quantum physics, gave his famous talk with the title There’s Plenty of Room at the Bottom in which he pointed to the possibility of manipulating the quantum behaviour of single atoms. This is exactly what is done today, fifty years later, in ion trap quantum ‘computers’.

In ion traps, a few research groups in the world are able to collect chains of 8-10 ionised atoms. Each of these atoms can be made to behave like a two-level spin-half system, called quantum bit or qubit. The bits are manipulated and flipped by laser radiation. Moreover, the ions are coupled together by their electric fields to a vibrating string, serving as a bus for transfering information between the qubits.

The simplest possible picture of a universal quantum register, valid for any physical realisation, is then a collection of atomic magnetic needles connected by springs, sitting like pearls on a string.

The qubit needle can point up (0) or down (1), but also in any direction in between. A bit represented by a flip-flop circuit in a classical computer can only be in either of the states |0⟩ or |1⟩. However, the quantum bit can be in both states at the same time in a ‘superposition’ of up and down, a|0⟩+b|1⟩. The qubit therefore has the power to represent much more information than a classical bit.

Increasing computational power

This gets even better when we consider two bits. Then the state of the classical bit register can be written as either of |00⟩ or |11⟩ or in a ‘superposition’ of both, |00⟩+|11⟩. The number of possible simultaneous states of the register is 2^2 = 4. Already with a register with 50-100 individually controllable perfect qubits one could in principle perform certain types of calculations that classical computers will never be able to do.

Part of this computational power has to do with something called ‘entanglement’, simply meaning that entangled states of the qubit register cannot be written as a product, like e.g. |00⟩|1⟩|1⟩|0⟩, similar to a single classical configuration. The quantum register (See Figure 1, overleaf) allows configuration mixing leading to non-classical correlations that simply cannot appear in a classical computer. Such quantum correlations coming from entanglement contribute to the power of the quantum computer. A typical such two-qubit state is the famous Bell state |00⟩+|11⟩, a ‘Schrödinger’s cat’ state, which implies that if one reads one bit to be 0 (1), the other bit will also be 0 (1).

Erwin Schrödinger thought experiment set about explaining the strange nature of quantum mechanics. He proposed a scenario with a cat in a sealed box, where the cat’s life or death was dependent on the state of a subatomic particle. According to Schrödinger, the traditional definition of how the quantum world works implies that the cat remains both alive and dead until the box is opened, which obviously is a very strange premise indeed.

This is what Einstein called “spooky action at a distance” but, even so, it is a proven fact of life – at the quantum level.

To build a working quantum computer is fundamentally to try to beat nature on its home ground

|0⟩ or |1⟩ or |00⟩ or |11⟩. But the two-qubit register can be written as a|00⟩+b|01⟩+c|10⟩+d|11⟩. This means that the register is in all 2^4 = 16 classical bit configurations at the same time! If we consider a register with 10 qubits, the number of possible simultaneous states of the register is 2^10 = 1024. Already with a register with 50-100 individually controllable perfect qubits one could in principle perform certain types of calculations that classical computers will never be able to do.

Part of this computational power has to do with something called ‘entanglement’, simply meaning that entangled states of the qubit register cannot be written as a product, like e.g. |00⟩|1⟩|1⟩|0⟩, similar to a single classical configuration. The quantum register (See Figure 1, overleaf) allows configuration mixing leading to non-classical correlations that simply cannot appear in a classical computer. Such quantum correlations coming from entanglement contribute to the power of the quantum computer. A typical such two-qubit state is the famous Bell state |00⟩+|11⟩, a ‘Schrödinger’s cat’ state, which implies that if one reads one bit to be 0 (1), the other bit will also be 0 (1).

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This is what Einstein called “spooky action at a distance” but, even so, it is a proven fact of life – at the quantum level.
Nevertheless, a 10-qubit quantum computer is only a toy computer, much like digital computers in the 1950's. So, do we have to wait 50 years for quantum computers to live up to our great expectations? The simple truth is that nobody knows. The present ion traps are not scalable and represent the end of a line. In order to scale up to larger systems with 50-100 qubits, to begin with, one must use solid-state micro/nanotechnology to scale down the components and build microtraps where ions can be stored and shuffled around. Such work is in progress, but there are not yet any significant breakthroughs. This takes us back to the starting point of scaling down solid-state systems using micro- and nanofabrication techniques to implant atoms in semiconductor hosts, or to fabricate artificial atoms in quantum dots or in superconducting circuits. In this way one can easily put hundreds or thousands of qubits in a register, but one may then have little control of the quantum functionality. If one implants ions and atoms into solid hosts, one has usually long lifetimes but poor control over positions and couplings. If one fabricates artificial semiconductor or superconducting artificial atoms using lithography, one can control positions and couplings, but may have severe problems with the qubit lifetimes due to decoherence.

The role of decoherence will determine the fate of the quantum computer. So far we have only talked about perfect qubit registers and disregarded that it is a harsh, noisy world, especially if one is a little qubit living deep inside a solid chip. The electric and magnetic noise from impurities and imperfections can make the qubit register (Figures 1,2,3) spin and flip in uncontrolled ways. Simply speaking, one has only the limited time between random unwanted flips available for performing the desired computations. This time can be so short that the qubits die before one has time to do anything useful.

Introducing the EuroSQIP solution
Here EuroSQIP comes into play with lithographically fabricated artificial-atom qubits in superconducting nano-and microscale electronic circuits (Figure 2). Superconducting circuits have no resistance, and there is a long tradition for building extremely sensitive SQUID magnetometers and single-electron and single-Cooper-pair transistors. About 10 years ago it became clear that these devices could be used as qubits, and a worldwide ‘race’ started to be the first group to demonstrate simple quantum computation in superconducting registers with 5-10 qubits. Many of the EuroSQIP partners started together in the FP5-SQUBIT project and were able to develop proofs of concept of several very promising and widely recognised charge and flux qubit circuits which are now further developed in EuroSQIP.

Four years ago, the original goal of EuroSQIP was to develop proof of concept of a universal quantum register with 5-8 superconducting qubits with individual control and readout of each qubit. Such a quantum register will simultaneously work as processor, memory and communication bus (Figure 3). Effectively the computation is performed directly on the memory, creating many-qubit wave patterns in the quantum wave function of the register, and then reading out information at appropriate locations and times. The present status of EuroSQIP is that we are still in the frontline, producing state-of-the-art results at the 2-4 qubit level. EuroSQIP partners have demonstrated universal gate operation for two-qubit circuits, and functional three-qubit circuits are presently being tested. Simultaneously, fundamentally important tunable readout, coupling and transmission circuit elements are being fabricated and tested. During 2009 we expect to be able to present significant progress with EuroSQIP at the three-qubit register level (Figure 3).
This is nevertheless some distance away from EuroSQIP’s original goals. Primarily, ‘fluctuations, noise and decoherence’ are the big problems, and are problems shared with all of the frontline teams in the US and Japan. To build a working quantum computer is fundamentally to try to beat nature on its home ground. A quantum computer needs to be completely isolated from the environment when performing computations, but open to the environment during operation and readout. It is physically impossible to avoid some decoherence via the necessary communication channels. And on top of that, the qubit register is fabricated in material that has various types of imperfections, creating disturbing fields that give the qubits random decohering kicks. The successful development of a large-scale universal quantum information processor is therefore in the end a problem of materials science! There are no solutions that can go around this roadblock. By improving materials, design and fabrication one will be able to expand the useful size of quantum registers and push the roadblock further ahead – but enormous challenges. The cherished notion of ‘which approach will win the quantum information battle’ is counterproductive, if not senseless. It is likely that no single physical system will be able to provide optimal performance. It is therefore essential to develop coherent quantum interfaces to build coherent atomic and solid-state hybrid systems with optimal properties for control, storage and readout of quantum information. Such hybrid systems could take many shapes, from compact systems on chips to distributed grid systems connected by coherent photonic channels. It will be a continuous development with constant improvements without end, pushing quantum computational power and entanglement toward the limits set by nature and future technologies.

**The quantum register allows configuration mixing, leading to non-classical correlations that simply cannot appear in a classical computer**
Small steps that will lead to Quantum leaps

The history of quantum mechanics is a history of revolutions. Scientifically, its discovery represented a radical paradigm shift with respect to contemporary physical theories. Technologically, its applications deeply affected everyday life. Some of the most far-reaching applications – such as the transistor and the laser – are the building blocks of current electronics and telecommunications, and have heralded the birth of information society as we know it today. Yet, they merely act as a support for a completely classical mode of processing information, where logical degrees of freedom exhibit no quantum behaviour whatsoever. The realisation of this fact led at the beginning of the 1980s to speculations about the possible use of quantum-physical systems to perform calculations of complexity unattainable by systems behaving classically. Around that time, coming from a completely different corner, several researchers were already investigating fundamentally counterintuitive aspects of the theory, like the superposition principle exemplified in the Schrödinger cat paradox and the ‘spooky action at a distance’ resulting from quantum entanglement.

Two theoretical breakthroughs turned these first, rather foundational inquiries into application-oriented research: the quantum key distribution (QKD) protocol of Gilles Brassard and Charles Bennett, presented in 1984, and Peter Shor’s quantum factorisation algorithm from 1994. Shor’s algorithm is a method for decomposing a number into prime factors in a time exponentially shorter than any known classical algorithm would take and, as such, provides a possible route to breaking many of the currently used cryptographic codes. The ‘BB84’ QKD protocol, on the other hand, provides – somewhat ironically – a way to transmit a secret message with absolute security, even against ‘eavesdropping attacks’ carried out with a quantum computer.

Both methods rely essentially on the ability to preserve and coherently manipulate superpositions of quantum states. This is relatively easy to achieve for quantum information encoded in photons propagating in free space or in optical fibres. Therefore, QKD – popularised as ‘quantum cryptography’ – has been developing quite successfully in recent years. But ultimately, for large bit rates or large distances (that is, more than about 100 km), noise and loss in photonic channels prevent secret bit transmission in practice. This limitation was lifted, in theory, about 10 years ago by introducing ‘quantum repeaters’. These are, in essence, error-correcting devices that counteract the effect of the ‘environment’ on the qubits (such perturbations are unavoidable because no quantum system can be completely isolated from its surroundings). In the more general context of quantum computation, quantum error-correction codes theoretically allow for arbitrary quantum computations to be performed even with faulty gate operations, provided the error probability per gate is sufficiently small.

Quantum conundrums

While solutions to attain the ultimate goals – that is, unconditionally secure communication and devices that deliver immense computational power – do exist on paper, the limiting factor for their actual implementation is that for arbitrarily scaling up the number of qubits in a quantum computer, or the distance covered by a quantum communication channel, the initial ‘uncorrected’ error rates have to be already quite small. Unfortunately, the required values are not yet attainable practically. Several schemes for high-quality quantum gates have been put forward, starting with the ion-trap quantum computer proposed in 1995 by Ignacio Cirac and Peter Zoller. An increasing number of groups are trying to implement quantum gates with different experimental systems.

In order to get a clearer view of the state-of-the-art of the current available systems for quantum information processing and communication (QIPC) and the challenges that have to be overcome on the way to its practical realisation, ‘roadmaps’ have been put in place on both sides of the Atlantic. One of the most important activities carried out by the coordination action QUROPE, supported by the European Commission’s Future and Emerging Technologies Unit, is thus the constant update and development of the ‘Quantum Information Processing and Communication Strategic Report’, also known as the ‘European QIPC roadmap’.

Illustration of the parallel entanglement of a very large number of atomic qubits, by using controlled cold collisions in an optical lattice (courtesy Immanuel Bloch, University of Mainz)
The platforms for QIP

According to this roadmap, the platforms for QIP fall roughly into two major categories: atomic, molecular and optical (AMO) systems, and solid-state systems.

In the first category, the brightest candidates identified so far are trapped ions, and atoms confined in optical lattices. Systems based on trapped ions lead the race with respect to controlling individually a few qubits (up to eight qubits, a ‘quantum byte’), whereas atoms in optical lattices provide a very large number of qubits in parallel, amenable to pair-wise interactions (individual addressability being the next challenge in this case). There are many other contenders, including photons within the ‘linear quantum computing’ approach, miniature traps for atoms or ions (known as atom chips or ion chips), as well as ‘continuous variables’ systems, where the usual qubit-based approach is replaced by continuous degrees of freedom, such as the amplitude of the quantised electric field, or collective spin in atomic ensembles.

Quantum communications

Within the vast range of QIPC activities, quantum communications and especially quantum cryptography are currently the most advanced ones, as far as applications are concerned. Several small companies worldwide are now selling QKD devices that yield decent data rates over distances of several tens of kilometres, and can be deployed in real case situations. For example, they have been used to protect a federal election that took place in the State of Geneva on 21 October 2007 against hacking or accidental data corruption in transmitting the electors’ votes. Moreover an Industry Specification Group (ISG) of the European Telecommunications Standards Institute (ETSI) has been created with the objective of bringing together the important European actors from science and industry (many large companies with an interest in telecommunication or information technology sustain an internal research programme on the subject), and start to address standardisation issues in quantum cryptography, and quantum technology in general.

Though there is clearly a long way to go, and no ‘working quantum computer’ yet, the recent successes outlined in the European roadmap justify an optimistic outlook on the future of QIP, not least in the face of the high expectations for applications that become possible once the technology has matured. The pace with which progress has been made, on both the theoretical and the experimental side, could not have been envisioned ten years ago. The major issues are well-identified, and all the first obstacles along the way towards practical working devices have been overcome, with controlled interactions and entanglement – required for scalable quantum computing – demonstrated with a number of physical systems. Also, there is a general consensus about the most important achievements so far, and the ways that should be taken, testified by strategic documents as the one described. Overall, research is progressing and becoming increasingly focused, with no signs of stagnation. Maybe the most difficult aspect to explain to outsiders – and ‘deciders’ – is that coping with the laws of nature has never been easy. Every step takes serious effort. And therefore, only long-term commitment will be successful. ★
Germany has a long history of innovative thinking and scientific excellence. Its universities are rich in tradition, having educated some of the finest minds in history, including Schiller, Hegel and Abbe, great thinkers and scientists whose radical ideas helped shape the world in which we live today. Looking to the future, new ideas and further scientific development are crucial if Germany is to maintain this reputation and build on the nation’s proud academic history, and by extension boost the country’s long-term economic prospects.

This progress is a shared goal of all European countries which, in the face of increasing levels of competition from emerging economies, see fostering research, development and innovation as a key means by which to enhance the overall regional economy. However, the complexity of the technological challenges we face means that close collaboration and effective international partnerships are a must if European research is to be advanced.

A city of science

Jena, a city in the region of Thuringia, exemplifies German scientific excellence. The city was recently awarded the title of ‘City of Science 2008’ by the Association of Sponsors for the Promotion of German Science in recognition of the quality of its research environment. However, the development of this environment has, of course, not come about overnight. The city’s academic culture is well-established and forms an integral element of Jena’s identity.

Research and science are taken very seriously in Jena, and indeed both have played an important part in the development of the city. Jena’s Friedrich Schiller University was founded in 1558, and over the past 450 years it has
established a formidable reputation for research excellence. This is a tradition that is being maintained. One in four Jena residents is a student at one of the city’s higher education institutions, while it is also home to over 30 research institutes, including a number of outstanding federal research establishments.

However, while scientific research has deep roots in Jena, the city’s progress towards the wider recognition it enjoys today has also been accelerated by external investment from the European Union. Designed primarily to stimulate development in the ex-communist bloc following the collapse of the Berlin Wall, the impact of this investment has been significant, and not just on Jena itself. Indeed, Thuringia as a whole has derived great socio-economic benefits from the EU investment directed at the region since 1989.

As such the city’s authorities fully understand the value of collaborating closely with European partners and sharing research advances in pursuit of shared goals. Jena’s rich scientific heritage has also left a strong legacy, particularly in terms of translating those research advances directly into economic progress and development, something that is an increasingly important objective for the academic sector as a whole. Again, applied research has deep roots in Jena. Carl Zeiss, Otto Schott and Ernst Abbe all worked in the city, and helped establish the symbiotic relationship between research, science, education and industry that endures today.

The link between advanced research and economic progress is well-established. However, these ties are particularly strong in Jena, and this strength goes a long way towards explaining the city’s continued success and reputation for research excellence. Scientific development and innovation has long been one of the foundations of the German economy, and its highly efficient, effective research networks stand as testament to the country’s ability to turn advanced scientific research into innovative new products and hence economic development, something in which Jena plays a key role.

Forward-thinking industry
Not only does the city play host to one of Germany’s foremost universities, but it is also home to a number of forward-thinking industries and leading-edge research institutions. Taken in isolation each brings real benefits to the city, but it is the collaborative work that has been undertaken between them that has really boosted the regional economy, while there are also other, less tangible benefits. Jena’s academic tradition has helped generate an atmosphere in which innovation is encouraged and development stimulated, which has attracted
At a glance

Information
Jena has developed into a high-tech and research location of international renown in recent years. This has mainly been achieved thanks to the city’s renewed awareness of its own strengths – Jena’s knowledge triangle, the alliance of higher education, research and industry that has made history since the days of Zeiss und Abbe. Thinking beyond boundaries has a tradition in Jena, and so has the commercial utilisation of innovative ideas. The Association of Sponsors for the Promotion of German Science elected Jena as the ‘Science City 2008’.

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Dr Albrecht Schröter

Jena Science City Mayor

Dr Albrecht Schroeter has lived in Jena since 1984, and has been extensively involved in the religious, social and political life of the city ever since. He became mayor of Jena in 2006.

Throughout its history Jena has demonstrated a commitment to development and hunger for innovation. This can be felt everywhere in the city.

Nor are the benefits of this kind of atmosphere limited in scope. A number of professionals from a diverse range of fields to the city. Researchers, development engineers and economists from across the world profit directly from this excellent research infrastructure and cosmopolitan environment.

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How to reorganise radio spectrum resources

Demand for wireless communication tools has grown rapidly over recent years, as mobile cellular technologies have become both more accessible and more affordable. However, with radio spectrum space a regulated common resource (radio communication can only be achieved in a specific frequency span), the question of how best to meet this increased demand for wireless communications presents a major challenge. “Since radio spectrum space is used for many kinds of applications, including audio and TV broadcasting, mobile phone communications and wireless access and military applications, the regulators have assigned specific chunks of spectrum for each of these applications,” explains Dominique Noguet of the ORACLE project, an EC-funded initiative aiming to develop a completely new method of managing and using radio spectrum resources. “There are several ways in which this growing demand for wireless communications can be met,” he continues. “One is by improving spectrum efficiency, and many projects have investigated how to increase throughput in a given spectrum bandwidth. However, this approach has some intrinsic physical limits. By contrast the ORACLE project is developing a radically new, pioneering approach, one which proposes a new organisation of the spectrum resource so as to improve the effectiveness of allocation.”

This approach is founded on a belief that radio spectrum resources can be used both more efficiently and effectively than is currently the case. ORACLE points towards measurements of real spectrum use, which show that considerable spectrum space is available when the space and time dimensions are taken into consideration, as evidence supporting his project’s
approach. “The perceived problem of spectrum scarcity is caused, in most cases, by inefficient spectrum management rather than spectrum shortage,” argues Mr Noguet. “With demand booming for communications tools, in terms of both the number of connections and also quality of service demands, it has become clear that a new paradigm has to be found in terms of spectrum management. ORACLE is thus focusing on key enabling technologies to improve spectrum usage in different scenarios. We have selected some scenarios in the wireless LAN (licence free) and the cellular context (licensed). The general idea is that an Opportunistic Radio (OR) terminal, if it is fully aware of the spectrum usage in its vicinity at a certain point in time, will be able to enhance its communication capabilities, or quality, by grabbing some available spectrum space.”

New technologies such as spectrum sensing algorithms and architectures capable of detecting the available resources, are central to this overall vision, which demands a real commitment to innovation and ongoing development. This is something of which the project is well aware, and which has thus encouraged ORACLE to pursue an entirely new approach to the issue of radio spectrum usage. “Cognitive engine and decision making entities to define which opportunity should be chosen, as well as efficient spectrum usage strategies – based on new schemes at the physical and MAC layers enabled by flexible hardware – capable of considering spectrum regulatory and usage policies, are also being developed within ORACLE,” outlines Mr Noguet. “These techniques go far beyond current terminal capabilities. ORACLE has led the way in this field by providing innovative, advanced solutions, as the concept of OR is a completely new way of looking at wireless communication technologies. A range of projects had previously addressed the spectrum scarcity system from the system side, meaning that any access control has been handled by the networks. However, rather than suggesting an incremental improvement of radio communication systems, ORACLE is proposing a rethinking of the way spectrum is accessed and managed, which is thus leading to radical innovation in the field.”

However, the development of opportunistic systems is an extremely complex goal, and it should be stressed that it is not solely about identifying opportunities through sensing, but also about determining which opportunity best meets the needs of the spectrum user. Intelligent decision-making tools are a crucial step towards achieving this objective, and the ORACLE project is playing a key role in furthering their development. “Our tools analyse, understand, learn, quantify, predict, and utilise opportunities by configuring terminals appropriately within their hardware capabilities and within regulatory rules for spectrum use,” explains Mr Noguet. “The context in which an opportunity may occur and be exploited – depending on the actual scenario user profiles, usage policies, or even regulatory policies – may influence the decision over which opportunity is the best suited. ORACLE has defined a policy driven engine that analyses the different physical parameters, information about the required QoS levels for the application requiring radio resources, and any other piece of information that may be relevant. With all these considerations having been taken into account, a highly optimised decision making tool is then responsible for analysing, categorising and modelling the primary spectrum users activities.”

The improvements this approach will bring are likely to be significant, yet the project is keen to build on this work by pursuing further research in complementary areas, not least the question of efficient
spectrum usage in unlicensed environments. While the demand for higher throughput is far from being fully sated, the ORACLE consortium is nevertheless confident that spectrum space is still available in unlicensed frequency bands, and points to other factors as having constrained this area. “Limitations in unlicensed environments such as the ISM bands are typically not due to spectrum shortage, but rather arise more from inefficient medium access (MAC) schemes, or from the fact that most systems utilise this spectrum in a best-effort, highly competitive manner,” says Mr Noguet. “Autonomous spectrum agility is not part of the radio standards which operate in the unlicensed bands. Here, OR spectrum sensing, together with spectral agile transmission, has been shown to significantly improve the spectral efficiency (and therefore spectral utilisation) of ISM band systems. On top of that, adaptive Orthogonal Frequency-Division Multiplexing-based PHY techniques have been studied throughout ORACLE. They provide a high degree of freedom concerning spectral allocations by switching sub-carriers either on or off. In doing so, even narrow spectral gaps of low interference can be identified and exploited, which in turn improves the spectral utilisation.”

Advanced expertise of this kind has a crucial role to play in helping further the development of communications tools, a goal of crucial importance given the interconnected nature of the global economy. The Oracle consortium is acutely aware of this wider perspective, and thus are determined to be at the centre of the global research, regulatory and standardisation process. “ORACLE plays an important role in the Cognitive Radio scientific community,” says Mr Noguet. “We aim to introduce new communication technologies, a process which demands that we take the regulatory and standardisation process into account and make sure our voice is heard. In this regard, ORACLE is very proud to be a key player in launching IEEE P1900.6 standardisation project. This helped us raise general awareness of ORACLE’s results.”

The project has already derived tangible benefits from this increased awareness. A number of parties have expressed their interest in ORACLE’s work, something which is encouraging the project to look towards further development. “During the lifetime of the ORACLE project we have seen an increase in interest from the scientific community in Cognitive Radio,” says Noguet. “Specific conferences are being organised, special issues of major journals on the topic are regularly being opened up for contributions, and almost all wireless conferences have a session on cognitive techniques. The 7th Framework ICT workplan also puts more and more emphasis on Cognitive Radio techniques. This proves that there is strong interest in Cognitive Radio, not only from the scientific community, but from society as a whole. This is encouraging the ORACLE consortium to push its research activities further.”

ORACLE at a glance

Project Title
Opportunistic RAdio Communications in unLicensed Environments

Project Partners
Commissariat à l’Energie Atomique (CEA) - France - prime contractor
The University of Surrey (UNIS) - UK
Technische University Dresden (TUD) - Germany
Philips Electronics Nederland B.V. (PHILIPS) - Netherlands
Instituto de Telecomunicacões (IT) - Portugal
IMST GMBH (IMST) - Germany
France Telecom (FT) - France
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. - Institute FOKUS

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Dr Dominique Noguet (MSc 1994, PhD 1998) is currently the head of the Digital Architectures and Prototypes laboratory (LASP) at the Laboratory of Electronics, Technology and Information (LETI) of the French nuclear agency (CEA). His current field of interest is on Flexible Digital Radios and their applications to Cognitive Radio. He manages Cognitive Radio activities at LETI and is the coordinator of the ORACLE project.
Nano-scale miniaturisation brings major benefits

The semiconductor industry is going through a challenging period. The ever increasing cost of technology development and associated plant investments to build the products derived from the technology are forcing the major players to share costs and establish trans-continental alliances as they push for further development, in particular that of the 32/22 nanometre (nm) technology node. Against this backdrop the work of the PullNano project, an EU-funded initiative aiming to push back the limits of CMOS (Complementary metal-oxide semiconductor) technologies, takes on particular significance, focusing as it does on an area of crucial importance to Europe’s economic future.

“What we have achieved in the PullNano project is the development of a 32nm CMOS silicon technology. For that we used an SRAM (Static Random Access Memory) as a demonstrator so as to prove and validate the technology,” says Dr Gilles Thomas, the initiative’s overall coordinator.

In the world of semiconductor technology nodes small is beautiful. However, the goal of developing ever-smaller nodes poses a number of significant technical challenges, says Dr Gilles Thomas of the PullNano project, who expands on his initiatives approach to pursuing this objective.
metal gate for the 32 nm which has been found to be the one giving us the best possible transistor variability and circuit consumption."

Limitless possibilities
While the general public may not be immediately familiar with technologies like CMOS, their importance is difficult to overstate. Indeed, with semiconductors being used in a broad range of industrial settings, CMOS is crucial to the effective functioning of a number of commonly used devices. “The CMOS technology is used all over the place and in all kinds of applications,” confirms Thomas. “This includes laptops, digital TVs, set-top boxes and cellphones, digital camera, GPS systems, game consoles etc... In fact, there are limitless possibilities! CMOS is the workhorse technology for digital electronic devices. In the project we were looking for developing technologies that do not consume a lot of power – not necessarily the highest-performance technology. So, our focus is on developing technologies with low-power consumption that could be used in most of the industrial/consumer settings outlined above.”

This latter point provides reassurance that research advances in areas like metrology and nanostructures can be translated directly into real, tangible improvements to everyday products, thus countering the common argument that such work is not commercially relevant.

Indeed, Thomas himself is keen to stress that his project’s work, far from being impossibly esoteric, in fact brings significant practical benefits to the commercial sector, particularly in terms of what is always the absolute bottom line for every hard-headed businessman – cost.

“Technologies with small feature size bring an improvement in both productivity and performance,” he outlines. “You can make more transistors per square millimetre, therefore you can sell more complex faster circuits or you can have a memory size that stores more data at the same price. The chip price is directly related to the number of square millimetres of silicon that is used to produce it. This is the driving force behind MOORE’s law and the International Technology Roadmap for Semiconductors (ITRS), which defines each new technology node.” Indeed, although the development of the 32 nm CMOS silicon technology has been widely applauded, this success does not mark the end of the research road.

While the development of ever-smaller transistor geometries poses a number of significant challenges – not least to manufacturers – the benefits offered by ever-smaller transistor size demands that development continues, in Europe the PullNano project has been playing a key role in pursuing that development. “The latter part of the project was devoted more to evaluating our technological options for the 22 nm technology and to trying to narrow down the options and find out what the right materials and the right architecture are for the 22 nm node,” explains Thomas, before suggesting that there are limits to what can feasibly be achieved.

Previous research
“The PullNano project represents the continuation of previous research which has provided us with a foundation to aim for an economically viable 22 nm technology node.” he continues. “However, that will bring us close to the ultimate limit of what we can do; although we could maybe then go one or two nodes further. With photolithography and plasma etch techniques we cannot break the barrier of the discreteness of matter and eventually land a contact hole on a single atom!

The ultimate refinements of those techniques are becoming prohibitively expensive.” Clearly technology cost is a key consideration for projects like PullNano which have developed with a view to eventually commercialising their findings. As such it may well not be the physics itself that limits further research, but rather the economics. This pragmatic
We are looking to develop technologies that do not consume a lot of power – not necessarily high-performance technologies. So our focus is on developing technologies with low-power consumption that could be used in industrial settings.

need the right design and the right product bringing value to your customer. The cycle time of designing, qualifying, and testing the reliability of the product and later getting it adopted, for instance, in a cellular phone platform of a company somewhere can take two years. So we develop technology in advance, but the product usually only comes in large volumes about two or three years later.”

These words reinforce the sense that PullNano is working very much to a long-term agenda, and indeed large amounts of the project’s work is future-focused. However, the short-term impact the project has had should not be neglected either, particularly in terms of the further research it has enabled. “Besides pursuing the main PullNano objectives we have had a knock-on effect on other initiatives,” points out Thomas.

“For instance, with a team of academic partners we have defined a new potential High-K material for the 22 nm node, a pretty complicated material based on a rare earth compound. Meanwhile, we have also developed new functionalities inside an open source software called MASTAR – which is presently used by the semiconductor international community to define the future nodes of the ITRS (International Technology Roadmap for Semiconductors). Pushing further than single transistor performance prediction we have developed a simulation for transistor variability and another one for simple circuit performance evaluation (like a SRAM cell). By circuit performance we mean speed or Signal to Noise Margin (SNM). This has been done in a tool that is globally recognised.”

In working towards goals of the complexity of the PullNano project, many small-scale, incremental steps need to be achieved along the way. In the course of the work, PullNano brought significant advances in other areas, meaning that the impact of the PullNano project extends beyond its own focus areas. “There are plenty of other fields where you need to improve, to be better, to acquire knowledge and know-how, and to master the details if you want to achieve the overall goal of 32 nm technology,” says Thomas.

“To illustrate, we have developed analytical methods to accurately map the stress in a transistor structure. This need for an accurate map at the nano-scale of the stress inside the transistor, stems from the fact that inside transistors we use stress techniques to improve the mobility of carriers (electron and holes). We have developed advanced analytical methods that have been patented and are completely new. We have also developed new metrology tools,” he continues, acknowledging that achieving 32 nm technology requires advances in a number of areas, work that the PullNano project, by bringing together research partners from across Europe, is well-placed to pursue.
On 4 September, The European Commission had official support from the European Parliament to simplify the approval for hydrogen powered vehicles on European roads. This is a leap forward in the development and marketing of clean and safe hydrogen vehicles.

On the road to cleaner cars

It might not be long before you will see hydrogen powered vehicles on European streets. The automotive industry may become more competitive by nurturing hydrogen technology in a context of promoting green issues – marketing ‘gold’ in the current climate (pun intended).

Commission Vice-President Günter Verheugen, responsible for enterprise and industry, said: “The agreement in the European Parliament is a big step forward in the introduction of hydrogen vehicles. They have the potential to make Europe’s air cleaner and reduce its dependency on fossil fuels. Setting common standards will ensure safety for citizens and will boost the competitiveness of European manufacturers. Now the EU Member States will have the final say and I hope for their support.”

Hydrogen is a clean energy carrier so when used as fuel in combustion motors or in fuel-cell systems, it does not produce carbon emissions (carbon monoxide, carbon dioxide, unburned hydrocarbons or particulates) which means using it will contribute to the improvement of air quality. Moreover, no greenhouse gases are produced from motor vehicles, although care will have to be taken that the production of hydrogen itself does not lead to an increase in CO₂ emissions.

As it stands at the moment, uniform requirements for hydrogen vehicles are not included in the EU vehicle type-approval system. This poses problems for hydrogen vehicle manufacturers when trying to place these vehicles on the market in the EU. Currently, even if a vehicle obtains national or single type-approval in one Member State, it is not guaranteed that the registration of this vehicle will be authorised in all the other Member States. Furthermore, Member States have the possibility to establish different requirements for issuing an approval certificate. This situation results in a fragmented internal market of hydrogen powered vehicles, as well as complicated and costly approval procedures, which discourages the introduction of this environmentally friendly technology.

The proposed single approval will be sufficient for the entire EU. At the same time, the Regulation will guarantee that all hydrogen vehicles put on the market in the EU are at least as safe as conventional vehicles. A Commission study shows that the simplified procedures could result in a saving of up to 124 million Euros in approval costs to vehicle manufacturers in the period 2017-2025.
With an explicit mission to support industry, Germany's Fraunhofer institutes provide an effective link between the academic and commercial sectors. This benefits our industrial customers, says Martin Schell of Fraunhofer HHI, who expands on their work with photonic components.

Fraunhofer Institute drives photonics development

The Fraunhofer Gesellschaft, a German research organisation with institutes spread throughout the country has, since being established in 1949, earned a global reputation for scientific excellence. This excellence, and the strong links that have been forged between the organisation and the commercial sector, have over the past 59 years made a significant contribution to the German economy and kept the country at the forefront of technological development.

This is a tradition that those at the cutting edge of research are keen to see maintained. "As a member institute of the Fraunhofer-Gesellschaft our overall aim is to develop leading edge technologies that are focused on real market needs and can be exploited and commercialised by both start-up companies and established enterprises," says Martin Schell of the Fraunhofer Institute for Telecommunications – the Heinrich Hertz Institute (HHI) – where research into photonic networks and components is ongoing. "Collaborating with companies, especially SMEs, is part of our daily life," continues Schell.

"We conduct publicly funded joint R&D projects, and also work on direct industrial contracts. This latter area is a must for a Fraunhofer Institute, not only because it is the Fraunhofer's mission to support industry, but also because it helps us to focus on research topics with real economic impact. In consequence, our SME oriented R&D activities are primarily directed towards short-to-medium term commercial exploitation." This kind of approach naturally limits the institute's involvement in longer-term research. However, Schell is keen to stress that the institute maintains a healthy balance and remains heavily involved in research into emerging topics and technologies likely to lead to future commercial development. "Being engaged in future-oriented research themes is very important for us," he confirms. "To remain competitive, we have to think about topics like 160 GBit transmission or quantum dot technology at least five years in advance. "We build partnerships with universities, for example the Technical University of Berlin, with whom we cooperate on several projects – including activities on quantum dots and Si-based photonics. From the application point of view, optical communications, including telecom, datacom, and satellite communication (in fact, customised photo-detectors were installed on satellites launched a year ago for inter-satellite communication) has been, and will continue to be, our main focus. However, we also pay close attention to other fields in which our expertise in photonic components can be well exploited, such as spectroscopy or Terahertz generation and detection."

Such a commercially-oriented philosophy seems to be more typical of a business enterprise than a traditional academic institution. Indeed, Schell himself says that the Fraunhofer Society leads its institutes increasingly as self-responsible business entities, reinforcing the growing trend for academic research to be driven by commercial needs. This is demonstrated by the comprehensive service the HHI institute provides for their commercial clients.

"We cover the whole value chain from design, front-end (epitaxy and wafer processing, mask fabrication) and back-end (i.e. bar and singulated chip processing), characterisation and testing, right through to qualification (if needed in collaboration with partners)," outlines Schell. "Profound know-how and equipment for the assembly of prototypes and manufacturing in low volumes is also available, with special expertise in high-frequency packaging. We offer all this
expertise as an industrial service to commercial clients. And of course we offer to develop prototype level optical devices – either from scratch or, more typically, from existing lab research samples – to directly meet customers’ needs. We often also commit ourselves to producing such devices. This is definitely a must for our SME customers, as transferring the developed product to an external production line is only justifiable from the cost and time-to-market points of view, once the product is established in the market and the volumes become interesting for an external manufacturer. This business model has shown itself to be extremely attractive for European and American SMEs as well. This ties in with the Fraunhofer strategy of internalisation, as in recent years we have been involved with an increasing number of interesting projects outside Germany.”

A clear example of the kind of research undertaken by the institute is provided by the Photonic Integration activities of the Photonic Component department at the HHI. Their research into both InP-based monolithic integration and heterogeneous integration has exciting implications for the development of the photonic devices industry. "Photonic Integration offers us the opportunity to design optics for the coming 100 Gbit/sec transmission standard, and still remain within our customers cost targets," explains Schell.

"In Photonic Integration, various techniques like CMOS-compatible silicon photonics, InP-based monolithic integration, and heterogeneous integration exist, and it is far from obvious, which technology is most suitable for which application. Our internal know-how, and our excellent connections to outside technology providers and Universities help us here to find the best solution together with our customers. Photonic Integration is also a good example for the synergies between the telecom and the non-telecom world: A telecom wavelength splitter to separate the data streams on different wavelengths may als be used as a detector in spectroscopy, and a tunable laser to transmit into such data streams may be the appropriate source. ”

These are exciting developments, and with the potential application fields of photonics including areas as diverse as telecommunications, aviation and laser printing, there is likely to be no shortage of demand for innovative new technologies. However, such technologies must bring real improvements over existing methods if they are to be adopted on large-scale basis, as Schell acknowledges. “In part because we have not yet achieved uniform growth of the dots, only a few of the potential advantages of quantum dot technology have taken tangible form,” he says. “We have been working on InP based QD laser diodes for a while and managed to get fairly good and highly competitive results. However, we are not yet sure whether quantum dot technology will eventually become a disruptive technology, and lead to the wholesale abandonment of the more well-established quantum well technology, or if it will remain limited to niche areas like code generation for Quantum Cryptography.” It is this combination of scientific excellence and commercial nous that has helped the Fraunhofer Institutes establish themselves as an integral part of Germany’s business and academic landscape. HHI is no exception, and with demand growing from a wide variety of sectors for ever-more effective photonic components, those within the institute are well aware of the need for ongoing development and continual refinement.

“The main historical driver for the development of photonics has been optical communication, and it will continue to be the main driver well into the future," predicts Schell. “However, photonics is an enabling technology that impacts on a variety of other application fields as well, including sensors, metrology and construction, and the medical sector.”

As a member institute of the Fraunhofer-Gesellschaft our aim is to develop leading edge technologies that are focused on real market needs and can be exploited and commercialised by both start-ups and established enterprises.
Breeding fish for a sustainable future

Since being established in 2003 the Innofisk project, a EUREKA-backed umbrella organisation formed to lead research into innovative aquaculture, has evolved significantly to encompass work in a wide range of areas. This includes market-oriented projects across the entire fish production chain, ranging from fish breeding and water recirculation right through to the possible re-use of fish meals and fish oils. “The Innofisk project began several years ago. We decided to study aquaculture – in particular fish breeding – in a contained environment in the open sea, that’s where it all started,” explains Pol van den Bergen, the overall project coordinator. “We decided to use obsolete tankers to do it on and to do everything offshore in an economically viable way. At the time fish breeding was not viewed as being economically feasible. However, our feasibility study found that fish breeding and aquaculture had an important place in Holland. In Holland we once had quite a good fishing fleet, but if you look at it now you’ll see that it’s virtually obsolete and that we don’t do much fishing in the open seas anymore. Bearing in mind that demand for fish is increasing, the gap has to be filled by fish breeding. As such we thought it was possible to re-establish aquaculture in Holland as an industrial sector.”

This increasing demand for fish presents a real challenge to both the fishing and aquaculture industries, particularly when the wider perspective is taken into account. There is real concern over the speed at which the world’s fish stocks are diminishing, and thus a simple reliance on trawling the oceans in ever greater intensity to meet short-term demand is likely to have severe consequences. Given these circumstances the Innofisk umbrella’s emphasis on sustainability and transparency takes on enormous importance. “We started this project with the longer term very much in mind,” confirms Dr Okker van Battenburg, another key figure within Innofisk. “Many people fear that fish stocks in the oceans will eventually run out due to a number of factors, including pollution, climate change and overfishing. If this happens then we will have to find a solution. You can do that on land of course, as it is done nowadays – or you can also do it at sea. Well, we anticipate that in twenty-five years time there will no longer be any space on land for fish-breeding. That’s why we thought that it should be done at sea.”

This decision to perform fish breeding in an entirely new environment like an obsolete tanker, while an innovative new approach to fish breeding, brings with it its own challenges. Not only is breeding in confined areas more costly than the open water alternative, but a number of added...
considerations have to be taken into account as well. “You also have to look at pumping systems, supply oxygen and take care of fish outside their natural habitat,” points out Martijn Lammers, another of the prime movers behind the project. “The main problem with established breeding methods is that the aquaculture standard now involves breeding in open water and using fish oil and fish meal as the main ingredients for fish food.

This is not sustainable, so eventually we will have to look at something else. With confined water breeding you are in control of both the fish and their environment – they can’t escape, that much is certain. So you can optimise what you do with food or what you need to do with oxygen, to basically take the same technological steps as we did with agriculture, and apply them to a new breed of animal. There are definite parallels between agriculture and aquaculture.”

**Sustainability of stocks**

One of the more obvious of these parallels is a high level of concern over the sustainability of stocks. The agricultural sector responded to these pressures with a clear new philosophy, and van den Bergen says the onus is very much on the aquaculture sector to develop a similarly innovative approach. “In the past we hunted buffalo to meet consumer needs, but in the end the we reached the conclusion that we had to farm bison and so on. We are going through a similar process with fish now,” he outlines. “This involves quite a high-tech approach – for instance, for eels you need quite a lot of know-how to get larvae from the eels, then how to turn larvae into clareveels, and then finally on how they become fully formed eels.

So, quite a lot of knowledge is involved. This is the perfect combination of technology on the one hand – in fact quite high technology, because it’s far more difficult to breed fish than it is to breed cattle – and the more traditional skills of handling fish, packing fish and auctioning fish on the other. We can also trade and sell fish as well. If a country wants to develop a technology-driven economy then this might be one of the areas of application.”

While there are undoubtedly similarities between agriculture and aquaculture, this does not mean that Innofisk is rigidly following a pre-determined approach. The adoption of large-scale intensive farming in the agriculture has, while increasing productivity, raised a number of ethical and sustainability issues, issues that the project is keen to address within their own initiative. “We look at fish welfare. That is an important political point, that you do not use the animal purely as a means of production,” emphasises van den Bergen. “The specific cost action – 867 – makes the well-being of the fish an important focus area. Reducing the level of stress they suffer makes it easier for the fish and makes it taste better – which has a positive effect on the economy. You can prove that it is connected. Talking about converting knowledge into economic activity is one thing, but implementing the philosophy in practice is a far more important issue. In Europe, we have to get used to the idea that we must not develop knowledge purely for knowledge’s sake, we have to use it as well. Think of all the unemployed fishermen in Spain, Greece and Holland, all the activities they were once involved in could be regenerated again in a far more sophisticated way.”

This latter point hints at the wider potential of Innofisk’s work, particularly in terms of possible commercialisation. Indeed, the initiative’s work has already attracted a lot of interest from the business sector. “Many industrialists have shown an interest in our work,” says van den Bergen. “We organised a national workshop on aquaculture – we expected 45 participants and in the event over 100 came. People are very interested but often feel that they lack the knowledge necessary to do it in a responsible way. They do not exactly know how to get into fish breeding – what kind of fish to focus on, what feed they need to deliver and how to deal with issues like water quality, recirculation and purification.

We try to provide them with that knowledge. We know that it will take some time before fish breeding, on a large scale, is done in a more responsible way. However, that’s a discussion we’re getting into. We are trying to get more attention focused on aquaculture research and development,” he adds, describing a process that his colleague von Battenburg expects will be accelerated over the coming years. “I think that in five years time the issue will have grown even more prominent,” he predicts. “What I also see is that open sea fish breeding will be replaced by closed systems. It’s more expensive of course, but it’s also more reliable. You can control it better.”

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**At a glance**

**Project Title**

InnoFisk

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**Pol van den Bergen**

Pol van den Bergen specialises in the conversion of knowledge into business, his main task as a partner in Trencavel Technology Management. After a spell at the Ministry of Economic Affairs, he was one of the founders of the SENTER Organization in The Hague. He chaired the National Coordinators during the Dutch Chairmanship in the EUREKA Programme and he served as the Secretary General of the Programme in Brussels. From 2000-2004 he headed the Government Foundation “Dreamstart”. Since 2000 he has been a Commissioner of Parnassia/Bavo Group, Mental Hospitals and Clinics in The Hague.
A Minister's inside view of the Egyptian ICT Strategy

**eStrategies:** Could you please introduce our readers to Egypt's ICT strategic objectives?

**Tarek Kamel:** In the end of 2006 we announced Egypt's ICT Strategy 2010. This strategy reaffirms the Government’s commitment to using ICT as an essential agent/component for Egypt’s socioeconomic development; and building an information society capable of capitalising on the emerging knowledge revolution. It aims at ICT reform and exporting of ICT services that lead to higher FDI in the sector. So over the past decade, the Ministry and its affiliates have been able to facilitate deployment of infrastructure, work on developing ICT human capacities, and create market opportunities. Collectively, and concurrently the Government and industry partners have actively and indispensably contributed to the implementation of Egypt's strategic ICT plans.

Egypt’s clear policy for deregulation and private sector involvement, aiming to support the socio-economic agenda of Egypt, has been a major driver to the success of the sector.

Those plans identified and expressed niche areas where Egypt’s competitive edge could best be exploited. Examples include natural language applications, business process outsourcing and knowledge process outsourcing.

Notably, Egypt has successfully mainstreamed ICT as part of its national development strategy over the last decade. The Government formulated an ICT Master Plan in 2000 to ensure the effective deployment of ICT infrastructure and accessibility tools and spread the...
culture of use of ICT within society. And in 2003 Egypt introduced its information society initiative, this mega programme aimed at reaching the citizens through providing the community with the latest ICT opportunities in e-access, e-education, e-health, e-content and e-government services, gradually closing the digital divide.

**eS:** ICT is clearly an important driver and catalyst within the Egyptian economy. Does the Egyptian Government view the ongoing development and implementation of such technologies as a key priority?

**T K:** President Mubarak has recently praised the contribution of the sector highlighting its proven impact on socio-economic development.

Indeed, the Government of Prime Minister Nazif acknowledges the immensity of ICT across all sectors of the economy. Education, health and government services remain key ICT priorities for us here in Egypt, since ICT delivers such clear added value in these areas; adding to that a forth factor which is innovation. All four have direct impact on job creation and economic prosperity.

Here I would like to point to the Government’s adoption of a national project to reform the educational system that is the Egyptian Educational Initiative (EEI). This initiative receives the patronage of Egypt’s First Lady, Mrs. Suzanne Mubarak.

The EEI is implemented in partnership with the World Economic Forum and its IT partners with an aim to enhance the effective use of ICT in pre-university, university education and for life-long learning. It aims at equipp[ing] students with skills of the future that will make them active participants in the global economy.

The EEI seeks to add value to the national education process in new and innovative ways, directly impacting the quality of education. A major component of the EEI is increasing access to technology; private-sector partners are playing a key role in this regard, providing equipment, software and services. Over the past two years, more than US$ 80 million has been invested in professional development and training of students, developing curricula, certification, content digitisation, infrastructure deployment, and hardware and software as part of the EEI programme activities.

Now the EEI’s third year is dedicated to impact assessment and exploring means of making the programme sustainable.

**eS:** A key component in Strategy 2010 is Innovation and ICT Industry Development. Could you please shed some light on current efforts and key milestones?

**T K:** Egypt aspires that knowledge, innovation, and applied research drive its ICT industry into the global economy. Innovation and ICT Industry Development are key components in the Strategy, and main areas of activity involve: Developing the ICT capacity of Egypt, Research and Innovation, Promoting ICT investment and Foreign Direct Investment (FDI) and Developing an IT enabled service industry. (Read more at [www.mcit.gov.eg/ICT_Innovation.aspx](http://www.mcit.gov.eg/ICT_Innovation.aspx)).

In the process of implementation of our plans and as a testimony of the interest of multinationals working in ICT to invest and expand their operations in Egypt to serve their clients in the Middle East and Europe from Egypt, several heads of ICT conglomerates have visited Egypt to empower the partnerships that already existed; adding new dimension to the relationship by placing significant emphasis on research and innovation out of Egypt. Examples of such visits and recharged partnerships materialised in the visit of Bill Gates in 2005 and the establishment of the Microsoft Innovation Centre located in the Smart Village, also the visit of Didier Lombard in 2007 announcing the opening of Orange Labs in Cairo located in the Smart Village as well, and finally the visit of Samuel Palmisano where he announced the creation of a new operation for IBM in Cairo, the nanotechnology R&D centre. Those three centres aim to export their achievements to serve customers in the region, Africa and Europe.

To boost the ICT-related research efforts and lay the foundation for such a culture in the region, I am certainly pleased to announce the introduction of Nile University’s world-class graduate research efforts. For it is currently establishing a number of centres-of-excellence where fields of specialisation include Wireless Intelligent Networks and Informatic Sciences. Additionally, NU is partnering with Cairo University and IBM in the newly announced nanotechnology centre where main fields of research within the coming period will be in the areas of simulation and modeling software, alternative energy sources, thin film silicon photovoltaics, and energy recovery for desalination.

Similarly, an affiliate organisation to the Ministry, the IT Industry Development Agency, implements a strategy that...
promotes innovation through a unique programme that focuses on the collaboration between industry and academia; serving market needs.

Our prime efforts in the fields of research during the coming period include Arabic Natural Language Processing (NLP) and speech applications. The growing size of the digital content on the Internet with different languages creates pressing demand for NLP for text and speech applications. Similarly, the massive spread of cell phones and extensive use of its applications adds to the potential of to the NLP applications and technologies. In this regard, we see Egypt is best suited to support this growing industry within the region, for Egypt has the critical human resources mass that can be capitalised. We build tool for socio-economic development. Synchronously, socio-economic development has to happen simultaneously within the region to make the necessary leap.

Over time, Egyptian technical expertise has been well respected in the region, we have always exported our talent, and expertise, products and services and certainly cultural and educational content. Egypt has been and continues to be a gateway to both Africa and the Arab world.

Specifically, more than 300 million citizens in our region speak Arabic, and due to a long history of exporting cultural content to the region (Egyptian Arabic accent is very well understood and popular in the Arab world), Egyptian ICT electronic/digital services and products are experiencing the same surge in demand.

In the context of Africa, we believe we are the gateway for the continent to the rest of the world. I personally believe, that from Africa IT-enabled services can be exported to the world.

We assert, we have a role to play; being part of this continent, to discover the untapped potential within Africa in the field of ICTs. I would like to shed light on development efforts that Egypt supports in ICT capacity building in Africa for we provide professional training in telecoms annually and this programme receives great demand.

Finally, I would like to point to our flagship project that gained the interest of several African countries, namely the Smart Village, our technology park. A number of African officials have requested our expertise and consultations in duplicating the model. Progress in this regard is underway.

Also we extend our support and expertise across our national borders in areas related to laws and regulations and experience in large-scale projects in education and government modernisation and services.

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Egypt believes that ICT is a major tool for socio-economic development. Synchronously, socio-economic development has to happen simultaneously within the region to make the necessary leap.

Our potential for contribution on the abundance of linguists, computer science graduates and engineers. In addition the majority of the NLP applications for the Arabic language originate from Egypt; examples include MT, search engine, OCR, TTS, ASR, spellchecker.

The creation of a specialised centre-of-excellence in NLP and human language technologies is in the pipeline. Its main mandate is to conduct situational analysis, draw a roadmap for Arabic language for 10 years ahead, and provide opportunities for training and qualification.

We find venues such as ICT 2008 ideal for networking and creating partnerships. We see it necessary to expose our efforts and achievements to our counterparts worldwide and to place Egypt on the map of innovation in digital technologies.

**ES:** What role do you see for Egypt in terms of furthering ICT development in neighbouring countries? Will encouraging development outside your own borders bring benefits to both Egypt and the region as a whole?

**T K:** Egypt believes that ICT is a major tool for socio-economic development. Synchronously, socio-economic development has to happen simultaneously within the region to make the necessary leap.

Over time, Egyptian technical expertise has been well respected in the region, we have always exported our talent, and expertise, products and services and certainly cultural and educational content. Egypt has been and continues to be a gateway to both Africa and the Arab world.

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**Dr Tarek Kamel**

Minister of Communications and Information Technology for Egypt

Dr Tarek Kamel was Senior Advisor to the Minister of Communications and Information Technology for five years before being appointed as the Minister. During this time he spearheaded a number of national initiatives to spread the use of ICT tools amongst segments of Egyptian society. The Minister is known for his visionary strategy to drive Public Private Partnership initiatives in order to develop Egypt’s ICT sector, leading Egypt into the global Information Society.
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Putting some OOMPH into the science of sea air

**With water occupying** approximately 70 per cent of the earth’s surface area, the sea has long held a special lure for the scientifically curious. However, significant gaps remain in our understanding of the oceans, particularly in terms of organic species and the way the atmosphere interacts with the sea. These are gaps in knowledge that the OOMPH project (Organics over the Ocean Modifying Particles in both Hemispheres), an EU-funded initiative bringing together a number of partners from across Europe, is keen to address.

“The focus of the project is on investigating the chemistry, biology and physics relating to organic compounds at the air-sea interface,” says Dr Jonathan Williams, the project’s overall coordinator. “We know that marine biology uptakes CO2 to form biomass. But as it does so it leaks other gases out into the environment – both into the air and into the seawater. These gases oxidise in both phases and can eventually affect the overlying aerosol, so there’s a kind of holistic system at the air-sea interface. It’s those interactions that we’re investigating within OOMPH.”

These interactions are themselves enormously complex, and thus the project’s work has involved both laboratory-based experimentation and also shipborne research in both the Northern and Southern hemispheres. Although himself a field work specialist, Williams is nevertheless keen to stress that the two areas play complementary roles in pursuing the project’s goal of developing an interactive ocean-atmosphere chemistry model. “Within the consortium there are field measurement specialists, there are people who mathematically model the air-sea interface, and there are also people who are more used to conducting biological experiments in the lab,” he says. “It’s really the synergy between these groups that has brought about our success. Typically we would measure certain phyto-plankton in the lab to identify their emissions. Then we would go into the field, and in areas where these phyto-plankton predominate we would seek to quantify these emissions. Finally these emission rates can be added to our air-sea models. So, it’s very much cooperation between partners that has driven our success.”

This success is all the more noteworthy given the relative absence of previous research into the subject and established conclusions on which to build. Indeed, while human oceanic exploration has a long history, the area of chemical interactions at the air-sea interface has until now not attracted a lot of attention, an imbalance that OOMPH is playing a key role in redressing. “One of the main reasons behind the development of the OOMPH project is that the system of the air-sea interface is really quite poorly understood,” explains Williams. “Our understanding of these fundamental natural processes is generally poor. We’re pretty good at measuring things we emit ourselves – for example car emissions and urban pollution. But our understanding of how the ocean responds chemically to global changes is poor.”

**Combining disciplines**

While this lack of understanding is attributable, in part, to the sheer physical difficulty of undertaking ocean-based research, other factors have also played their part, not least a lack of coordination between those in complementary disciplines. With the project combining chemistry, physics and biology within its overall remit, OOMPH is well-placed to avoid such pitfalls. Indeed, Williams says his initiative represents a new approach to ocean-based atmospheric research. “Historically, when research cruises have gone out to sea they were typically quite segregated. So, oceanographers would bunch together, go out on a cruise and investigate the movement of water, while atmospheric chemists would go out separately on another cruise to investigate the air,” he explains. “It’s only been recently, under an international research forum called SOLAS (Surface Ocean Lower Atmosphere Study) that these groups of people have...
that we wanted to gain specific information on. Take the atmospherically important molecule acetone. We wanted to find out whether this phyto-plankton bloom was either releasing or uptaking acetone from the atmosphere. To do that properly we had to develop an entirely new type of flux measurement technology. We built that technical development into the start of the project. On the cruise we were able to take flux measurements of acetone across a bloom and obtain the answer that we sought.

Exploring the scientific possibilities
While the project was of course keen to look at these kinds of specific issues, they were also determined not to limit themselves to addressing solely pre-determined problems. In an area the size of the Southern Ocean the ability to adapt to unexpected situations is a crucial attribute and can lead to significant research advances, something of which Williams is well aware. “You have to be ready to be surprised in fieldwork,” he asserts. “You can of course have expectations before you set off, but I think that on every field experiment I’ve been on there’s been a certain element of surprise. There has always been either some unexpected emission or dependency between compounds which perhaps reveals a new mechanism, or an unexpectedly high or low value for a particular chemical. If the opportunity is there – in situ – to further investigate or gain information to understand that process then of course you have to react and complete further experiments, even if you do not have well-established procedures for those experiments.”

One of the main reasons behind the development of the OOMPH project is that the system of the air-sea interface is really quite poorly understood

One of the main reasons behind the development of the OOMPH project is that the system of the air-sea interface is really quite poorly understood. This opportunity to work in a new research area, while exciting, presents particular challenges for scientists. In particular, the lack of a precedent on which to base expectations and establish exactly which tools and technologies are required can be a major issue. As such Williams says the OOMPH project, in the shipborne research phase, was keen to combine an exploratory philosophy with the pursuance of some clear objectives. “We knew before we headed out, from satellite pictures, that every year in the Southern Ocean there is an enormous phyto-plankton bloom,” he outlines. “We didn’t know exactly what was coming out of this bloom, so we decided to take as many detectors as possible. However, we already knew of certain problems regarding this bloom being drawn together to share information and gain a better understanding of the air-sea interface.”

The French research vessel Marion Dusfresne at sea in the pristine Southern Hemisphere, (Photo courtesy of Marie-Helene Pertuisot)
At a glance

Project Title
OOMPH - Organics over the ocean modifying particles in both hemispheres

Project Partners
• Max Planck Institute, Germany
• CNRS/CEA, France
• CNR, Italy
• EPC, Italy
• University of East Anglia, England
• IFM-GEOMAR, Germany
• University of Ghent, Belgium
• University of Antwerp, Belgium
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Dr Jonathan Williams
Atmospheric Chemist

Dr Williams is an atmospheric chemist. He received his BSc in Chemistry and French and his Ph.D. in Environmental Science from the University of East Anglia, England. Between 1995-1997 he worked at the NOAA Aeronomy laboratory in Boulder, USA. He has participated in many international field campaigns on aircraft, ships and at ground stations. His present research involves investigating the chemistry of reactive organic species in the atmosphere, in particular over the Tropical rainforest and in the marine boundary layer. Dr Williams leads a research group focussed on Volatile Organic Compounds (VOC) at the Max Planck Institute for Chemistry in Mainz, Germany and is an honorary Reader at the University of East Anglia, UK.

Sensors mounted on the bow of the Marian Dufresne – the way ahead is flanked by two icebergs

We've still only scratched the surface – but already we've generated a lot of new results that we'd like to follow up

eStrategies | Projects
Europe's changing demographic profile is placing great strain on our healthcare infrastructures. Home-based health interventions will help relieve some of the pressure, says Lorenzo Chiari of the SENSACTION-AAL project, who expands on their role in bringing this vision closer to reality.

Healthcare technology for an aging population

Today nearly 14 per cent of Europe's population is older than 65, a figure expected to grow to 28 per cent by 2050. By 2050 Europe will have a population of approximately 80 million older people, who between them will present widely varying care and support needs.

This demographic change will have far-reaching effects on the European economy, while the societal impact will be no less significant. From this latter point of view the main challenge will be to preserve, for as long as possible, the independence of older people. This will allow them to enjoy their old age and will also relieve their relatives of the burden of care. Meanwhile, from an economic point of view, meeting the healthcare needs of the older people will put enormous pressure on European healthcare systems. Therefore, one of the main challenges faced by Europe as a whole is reducing the cost of providing medical assistance to older people without compromising the quality of care.

In this context the fact that physical activity-based interventions can improve the overall health of older people takes on enormous significance. Improvements can be brought about in both sufferers of age-related pathology and also those who remain unaffected, further reinforcing the broad relevance and potential impact of this new approach to healthcare. In specific areas of the elderly population, such as those prone to falls or patients with Parkinson's or Alzheimer's disease, research indicates that physical activity-based interventions have the potential to improve both cognitive and motor functioning. The available evidence suggests these positive effects are heightened further when interventions take place over longer time periods, are
individually tailored, and also include exercises in the home environment.

Given these benefits it is no surprise that there is a real focus on research efforts aimed at enabling home-based health interventions, and the exciting developments of recent times have brought this overall vision closer to becoming a reality. Technological advances have made it possible to use body fixed sensors, in combination with advanced ICT solutions, to provide highly effective monitoring of the health of older people in their own homes and introduce biofeedback-like interventions tailored specifically to individual needs. This new approach enables ‘telemedicine’ solutions where, from a distance, medical professionals can monitor older people in their home environment and provide tailored interventions. Although the technology necessary to realise telemedicine solutions is available, there is a clear need to develop feasible solutions in order to put this overall approach into practice.

This is an area of research which the SENSATION-AAL project (SENSing and ACTION to support mobility in Ambient Assisted Living), an EU-funded initiative which brings together both academic and commercial partners from across Europe, is playing a key role in furthering. The project’s ultimate goal is to prevent injury that will allow medical professionals to initiate interventions in the home before a problem turns into a crisis. With this in mind the SENSATION-AAL architecture will introduce new ICT solutions that will make the proposed system easy-to-use, active at all times and cost-effective. Such technologies must of course be both rigorous and reliable, not to mention highly sophisticated, if they are to fulfil their intended function as a central element in healthcare for older people.

By 2050 Europe will have a population of approximately 80 million elderly people, who between them will present widely varying care and support needs. This demographic change will have far-reaching effects on the European economy, while the societal impact will be no less significant.
These are requirements of which SENSACTION-AAL is well aware, hence the project’s emphasis on developing state-of-the-art technologies in the field of ambulatory assisting devices. Work to design, test and release a next-generation, smart, wireless on-body system is ongoing, and multicentre clinical trials will start soon. The system will enable both the monitoring of daily activities (Tele-monitoring), the simultaneous real-time active control of physical performance (Tele-rehabilitation). This work is crucial to improving the safety and security of balance and movement among older people. If crises do happen then tele-care will also help lessen the consequences of falls and injuries.

These are radical developments, and the rapidly evolving nature of the field suggests there is more to come. In these circumstances the accumulated wisdom of older people themselves represents an important resource on which the project can build and modify its architecture. To this end SENSACTION-AAL aims to identify knowledge relevant to the development of wearable technology aimed at supporting balance and mobility in older people. The survey of scientific and commercial domains focused on a number of areas; including the promising research that has been undertaken on motor control, in particular the control of gait and posture. The project partners also looked at wearable technology for monitoring movement activities, biofeedback systems, the overall market availability of up-to-date technologies for monitoring movement activities and biofeedback systems.

This survey has generated some interesting results, and points towards several potential solutions for monitoring the mobility of older people and introducing augmented feedback solutions for balance training. However, although a number of potential methods are available, there remain relatively few studies presenting either the results of long-term mobility monitoring or analysis of habitual activity patterns in people over the age of 65. Indeed, while recent research points to a number of promising directions in which augmented feedback can be applied in the area of balance training, there is little evidence to suggest that these solutions can be applied over the longer term to support mobility in older people.

The commercial availability of up-to-date solutions for augmented feedback balance training is limited. At present, no such systems are available for use in a home environment. This is a shortcoming that the SENSACTION-AAL project partners are working hard to address. The project incorporates expertise from a wide range of areas, including biomedical engineering, geriatric medicine, movement science, neurology, rehabilitation and microelectronics, leaving Sensaction-AAL well placed to pursue its goals.

Quality of healthcare and treatment of older people have long been two of the key measures by which societies measure themselves, and enabling home-based health interventions will bring significant improvements to both. As such the SENSACTION-AAL project and the systems it is developing could potentially have an important impact on the quality of life of European citizens. These new systems will empower persons with disabilities and citizens to play a major role in society, thus helping them both retain their own independence and also fully realise their own potential.
Getting under the skin of tissue elasticity

The many complex features of aging are far from being fully understood. Aging is generally accompanied by several 'age-associated' diseases, most of which involve a level of tissue disorganisation in organs and the surrounding environment. One of the clearest manifestations of aging is in the loss of tissue elasticity. This has a knock-on effect on both skin elasticity and also, although this is more difficult to appreciate, on breathing and the regulation of pulse pressure and, in consequence, cardiac function.

Elastic fibre synthesis occurs during development and early adult growth but is rare in adults, where it is often associated with the formation of non-functional elastic fibres and pathology. In humans, the age-related dysfunction of elastic tissue is associated with arteriosclerosis, aneurysms, hypertension, varicose veins, skin wrinkles, hernias, lung emphysema, the degeneration of inter-vertebral discs, ligaments or tendons, and also macula degeneration or glaucoma. Furthermore, the lack of elastic fibre formation explains the poor ability of skin to repair itself after severe burns; while the pathologic accumulation of amyloid-like elastin deposits is a classical manifestation of solar elastosis. Therefore, the aging of elastic tissues is related to general aging and thus can be considered to be an amplifying factor in the aging processes.

The mechanisms that govern correct elastogenesis are still unknown. However, fundamental research over the last decade has helped improve our understanding of the composition and assembly of elastic fibres. Besides the determination of about 30 components that build up the elastic fibres, several defective genes in inherited disorders of the elastic fibres have also been identified, such as those for Marfan Syndrome, Cutis laxa, Pseudoxanthoma elasticum or, more recently, Exfoliation Glaucoma. This work has enabled us to propose a therapy for children displaying Marfan syndrome.

With the potential enabled by this ongoing, exciting research at the forefront of their thinking, several European teams in the field have decided to coordinate their efforts so as to find 'positive modulators' for elastic tissue aging. The goal of the ELASTAGE project is thus to target the issue of elastic tissue aging so as to improve the ways in which we cope with aging, or at least with the manifestations of aging. The project has been supported by the European Community through the FP6 programme (2006 – 2008) and brings together 12 participants from six different countries in complementary areas of expertise. The participants include basic scientists, clinicians and several small enterprises, while ethical, gender and standardisation aspects are also taken fully into consideration. The collaborations that have been established throughout Europe, and indeed across the world, have expanded this network further, while the consortium participants are also the main organisers of the biennial Elastin European Conference.

The originality of the ELASTAGE project lies in the coordination of strategies for:

(i) the development of molecules that could protect or delay the degradation of elastic fibres or age-dependent modifications or,

(ii) the discovery of active compounds that could induce functional elastic fibre synthesis in adults.

It is hoped and expected that this work will lead to a breakthrough in skin and vessel aging treatments, which will in turn bring with it particular improvements in the treatment of chronic vein insufficiency and also, over the longer term, other joint, artery and macula disorders. Not only that, but the healing process itself will also be significantly improved, further reinforcing the broad importance of our work.

One of the main difficulties in trying to understand human aging mechanisms is finding an appropriate model. With the exception of the skin, healthy donor tissue samples are not obtainable, while animal models all display positive or negative aspects. The consortium is sharing human cells from either aged donors, cells from donors displaying accelerated aging (Cutis laxa and Pseudoxanthoma elasticum) or cells from varicose vein tissues. These cells, obtained during clinical

Wrinkles are a highly visible manifestation of ageing and a lucrative industry has evolved trying to eradicate them. Tissue elasticity is central to this work, says Dr Pascal Sommer of the ELASTAGE project. He explains how this will bring real benefits, and not just to the cosmetics industry.
investigations, have been used to develop equivalent tissues which partly mimic the properties of the natural tissues. Meanwhile, three animal models have also been selected by the consortium so as to test the effectiveness of the ‘positive modulators’. These rodent models display the characteristics of accelerated aging, for example an aortic elastin deficit. One mouse model has been obtained through a genetic modulation of elastic gene expression, while one model has been chosen for the short life span it has inherited (the so-called ‘senescence accelerated mouse’) and another has been selected because of its high susceptibility to arterial pathologies (the so called ‘Brown Norway rat’). Besides the physiological, histological and biochemical parameters that have been worked on – studies necessary if we are to assess the evolution of aging – the consortium has also purposely developed a DNA array dedicated to elastic fibre genes (Elastarray).

It is hoped that this work will lead to a breakthrough in skin and vessel aging treatments, which will in turn bring with it improvements in the treatment of chronic vein insufficiency, aneurysms, cardiac valves graft or skin aging.

One objective realised by the consortium has been the definition of the main site of elastic fibre degradation. This has been particularly helpful in terms of identifying protective molecules that could limit the degradation of elastic fibres. These molecules are chemically derived from the heparin structure (‘heparan sulphate proteoglycan’ derivatives). Different elastin fragments have also been proposed that could hinder, or indeed eliminate, the possibility of amyloid deposits derived from elastic fibres being formed, which might be seen to be a consequence of solar aging.

ELASTAGE has been also successful in proposing biomaterials that display the biomechanical properties of elastic tissues: this is particularly important in terms of the design of cartilaginous, vascular or cardiac valve grafts. These biomaterials have been proposed on the basis of the consortiums work in carefully detailing the chemical and biological characteristics of elastic tissues.

The anti-hypertension drug Minoxidil (‘a potassium channel opener’) has been selected as a good candidate for the role of activating the formation of the elastic fibres of the aorta. This has been demonstrated using our rodent models. Assays are in progress at the present time on cells from human varicose veins. As Minoxidil is already used in clinics, our results could potentially be used to improve the therapy and treatment of Williams Syndrome patients, who exhibit an inherited deficit of elastic fibres. Molecules with the same activity could also be derived for prophylaxis purposes among the elderly.

Meanwhile two antioxidants (vitamin E and Resveratrol) cause a reduction in the activity levels of the reactive oxygen species, which are the main contributor to aging at the tissue level. These two molecules could play complementary roles in limiting the negative impact of the evolution of elastic tissue during the aging process.

A dill extract, which was selected through a screening process from a plant extract library, has proved capable of efficiently activating the formation of elastic fibres in the case of both human cells and also a human skin equivalent, as well as volunteer women. In this latter case, dermatological trials concluded that the dill extract decreased the number and size of wrinkles on the face and improved the elasticity of the skin.

In summary ELASTAGE, which has been supported throughout by the European Community, has been successful in bringing to life innovative (and sometimes patented) reagents that could be useful for the maintenance of the elastic properties of the body, both during the aging process and also for bioengineering. This programme, which follows another based more on fundamental research (TELASTAR, 2002 – 2004), has allowed the construction of a true and strong European research community, the goal of which is to better understand the degradation and synthesis mechanisms of Elastin fibres, research planned to translate directly into improving the well-being of European citizens.
Managing knowledge for brain tumour classification

In the on-going global battle to thwart cancer in its many guises there are new innovative technologies that are being devised that can make a big difference to the approach to this particular healthcare battleground. One significant milestone, specifically in the fight against brain cancer, is the system created by the EU funded HealthAgents project, namely the Agent-based Distributed Decision Support System for Brain Tumour Diagnosis and Prognosis.

Before looking into this in more depth let’s take a look at the nature and the broad challenge of this form of cancer.

Personal reality

For 100,000 European inhabitants the horror of having a brain tumour is a personal reality. To make matters worse for healthcare institutions there are no life-style associations that can be attributed to brain tumours as with lung cancer and its strong link with smoking, and therefore there are no known preventative measures that can be adopted. It is a cancer that can develop in any age group. Indeed in the younger population, childhood brain tumours are the most common solid malignancies. At the other end of the age scale the problem is also growing, due in part to the increasing general life expectancy of the European population, which make elderly healthcare issues such as brain cancer multiply in frequency.

Nowadays, if a brain tumour is suspected, in order to obtain a clear diagnosis, a biopsy using a needle to remove a sample of brain tissue will be performed. The tissue is then studied by a pathologist under a microscope to hunt for ‘tell tale’ cancer cells. If cancer cells are discovered, the doctor may decide to remove as much tumour as he can and this procedure may occur during the same surgery. This may be followed by an MRI scan to see if cancer cells remain and tests will be performed to determine the grade of the tumour. In this biopsy for the histopathological analysis, there is a risk of 2.4-3.5 per cent morbidity and 0.2-0.8 per cent mortality, in addition to healthcare costs and considerable stress to patients. The Magnetic Resonance Imaging (MRI) scan also only achieves 60-90 per cent accuracy, depending on the tumour type and grade.

So in conclusion diagnosis and prognosis for brain tumours is fraught with very serious problems, problems which have distressing affects on patients or in worse case scenarios can kill them.

An alternative way

HealthAgents is an open source web-based distributed decision support system (DSS) which provides hospitals and organisations with a reliable tool to aid in the diagnosis of brain tumours and their prognosis aiming to avoid invasive surgical procedures.

Its objective is to improve the classification of brain tumours over a distributed network of local databases. The HealthAgents system implements novel pattern recognition discrimination methods in order to analyse in vivo MRS and ex vivo/in vitro HR-MAS and DNA data. It will compile, evaluate and use parameters to rank classifiers and to also improve them periodically.

HealthAgents is not only applying advanced agent technology to the biomedical field, but also nurturing the HealthAgents network, a globally distributed datawarehouse for brain tumour diagnosis and prognosis. This is a global network of distributed brain tumour information and a knowledge repository comprising some of the leading European centres of excellence in neuro-oncology. It will supply clinicians, histopathologists, epidemiologists, radiologists, and...
neurosurgeons with an efficient computer-based neuro-oncological diagnosis tool. It will also supply researcher and academics with a research tool to study brain tumours but perhaps most importantly it will mean patients and clinicians have the possibility of avoiding a risky and costly biopsy.

The HealthAgents approach builds on a wealth of experience in biomedical informatics, particularly in signal processing and computer-aided diagnosis, where physiological and molecular level tumour discrimination are becoming increasingly used for the early detection of tumours. As a result, a high level of accuracy in tumour classification has been achieved, and with these excellent results, HealthAgents intends to lead the area of classification and non-invasive diagnosis and prognosis for patients with brain tumours.

The HealthAgents network will develop steadily to encompass individuals and organisations committed to improving brain tumour diagnosis, enabling them to share resources, architecture, clinical data, and information systems. Indeed, this visionary network will enable cooperation among researchers and clinicians across Europe and the world.

HealthAgents has been developed by a multidisciplinary European consortium with key contributions by the following institutions: Hospital from Bellvitge, IDI – Hospital Vall d’Hebron, CETIR, Hospital del Mar and Hospital Sant Joan de Déu from Catalonia, Hospital La Ribera-Alzira, IVO, Hospital Quirón and Hospital Clínico Universitario from Valencia (Spain) and the Children’s Cancer and Leukaemia Group (CCLG) centres in UK. New clinical partners are also welcome to join the network as the Jiangsu Province Hospital from China has already done.

There are several brain tumour types and grades, so the development of robust classifiers with a dozen samples of each tumour and (sub)type is a daunting task. According to analysts, there are some 15,000 MRI/MRS centres worldwide and, assuming, 100 cases per centre, there is a potential requirement for storage and classification of 1.5 million cases. By delivering an industrial-grade system, HealthAgents wants to set the standard for geographically-distributed computer-assisted diagnosis and prognosis of brain tumours. As early and accurate diagnosis may avoid a biopsy, costly in terms of morbidity and mortality, HealthAgents will enable better treatment and planning, and facilitate the development of accurate methods to monitor prognosis. It is arguable that HealthAgents may help to minimise healthcare costs and ultimately improve the quality of life for Europeans.

**In summary**

The project has created an open-source web-based distributed DSS and its associated Datawarehouse to help on the decision making process followed by the clinicians for the diagnose of their patients and easy access for visualisation to MRI, MRS, genomic and molecular imaging data from brain tumours. Particular attention is paid to child brain tumours, which have a different aetiology and social impact compared to adult brain tumours.
A fairy tale fantasy is to become a scientific reality

Mankind has often dreamt of suspended animation, a prerequisite for long-distance space flight. Many species, from bacteria to mammals, have evolved dormant stages, enabling them to survive unfavourable conditions. Learning from nature is a first step to manipulating dormancy. Finding the technology to make any cell, tissue, organ or organism enter dormancy artificially, and be revived, would bring enormous benefits in many fields. However, the biological mechanisms underlying dormancy are poorly understood, while the data is frequently fragmented or anecdotal.

The ‘Sleeping Beauty’ project addresses the need for a better understanding of dormancy. A multidisciplinary team was assembled which crosses the boundaries of ecology, physiology, biochemistry, developmental biology, molecular biology, bioinformatics and genetics. Model organisms are being investigated to reveal the strategies they employ for long-term survival in dormant stages. The cellular mechanisms used to enter and exit dormancy, and to tolerate stress, are also being identified. The lessons learnt will assist in the development of novel methods for cell preservation. This project is conducted within the framework of the FP6 NEST (New and Emerging Science and Technology) Adventure programme. This unique programme gives scientists an opportunity to propose visionary interdisciplinary ideas that cannot be funded otherwise.

Potential for preservation

The ‘Sleeping Beauty’ partners are assessing to what extent dormancy could be artificially induced in cells or organisms at ambient temperatures. The knowledge gained about cellular mechanism will be used to develop novel methods for cell and tissue preservation, where it is feasible. This will involve the manipulation of gene expression to alter cell function in order to shut down metabolic activity. Levels of specific proteins (e.g. heat shock proteins), carbohydrates (e.g. trehalose) or other compounds could be raised in cells by these means.

The project will have long-term impacts in the fields of biotechnology, ecology and medicine. Cell-preservation technology could aid nature conservation programmes, for example, by helping to maintain the genetic diversity of endangered species. Tissue and organ preservation techniques would be of

Fig. 1: The conceptual organization of the research project includes five model organisms:
1) Cyanobactetrium (Aphanizomenon ovalisporum) - Akinetes
2) Baker’s yeast (Saccharomyces cerevisiae) - Spores
3) A rotifer (Brachionus plicatilis) - Resting eggs
4) An Arctic springtail (Onychiurus arcticus)
5) Embryos of a killfish (Fundulus heteroclitus)
Finding the technology to make any cell, tissue, organ or organism enter dormancy artificially, and be revived, would bring enormous benefits in many fields.

Five research groups are studying five taxonomically diverse organisms. Two groups at the Israel Oceanographic and Limnological Research (IOLR), the National Institute of Oceanography (NIO) and the Kinneret Limnological Laboratory (KLL) are working on rotifers and cyanobacteria, respectively. Cyanobacteria have specialised dormant cells (akinetes) that tolerate unfavourable environmental conditions while rotifers produce eggs containing development-arrested embryos after sexual (but not asexual) reproduction. Baker’s yeast can survive for long periods in a spore phase, characterised by desiccation and high levels of the sugar trehalose, until nutrients for growth become available. This is being studied at Göteborg University in Sweden. Arctic springtails, under investigation by the British Antarctic Survey, are able to reduce their body water content to avoid freezing, while also producing trehalose and becoming metabolically inactive. Finally, killifish embryos in eggs deposited on the shore by high spring tides show a high desiccation resistance, and hatching remains arrested until the process is triggered by water immersion during the following spring tides. Killifish are being studied at the Institut de Recerca i Tecnologia Agroalimentaries in Spain.

Two other partners are applying frontline tools to aid the model studies. Genomic research is being carried out at the Max-Planck Institute for Molecular Genetics in Germany, while cell metabolomics is being studied at the Technical University of Denmark. These state-of-the-art technologies have not previously been applied in this research direction. The aim is to discover the genes that are expressed, and the proteins, carbohydrates and other compounds produced, that establish the stress-tolerant dormant stages observed in the model organisms. The findings will guide further studies on the genetic regulation of mechanisms driving dormancy.

Two other partners are applying frontline tools to aid the model studies. Genomic and proteomic research is being carried out at the Max-Planck Institute for Molecular Genetics in Germany, while cell metabolomics is being studied at the Technical University of Denmark. These state-of-the-art technologies have not previously been applied in this research direction. The aim is to discover the genes that are expressed, and the proteins, carbohydrates and other compounds produced, that establish the stress-tolerant dormant stages observed in the model organisms. The findings will guide further studies on the genetic regulation of mechanisms driving dormancy.
at the Technical University of Denmark. These state-of-the-art technologies have not previously been applied in this research direction. Transcriptome analyses, also involving high-throughput techniques (e.g. EST libraries, microarrays and Solexa sequencing technology) revealed some common pathways involving genes regulation during entrance into dormancy. These include genes associated with protection against reactive oxygen species, maintaining the native folded conformation of proteins (such as genes coding for ‘heat shock proteins’ or chaperones), genes coding for LEA (Late Embryogenesis Abundant) proteins, trehalose synthesis and aquaporins (cell membrane proteins associated with water transport). It is possible to envisage these genes as a template, whereby each organism chooses to use some of them and not others. A wide scope of the variation between species and ecological niches is provided by the studies on the five model species and by comparisons with other organisms such as plant seeds and mammals displaying hibernation. The findings will guide further studies on the genetic regulation of mechanisms driving dormancy.

**Discussions**

A workshop titled *Sleeping Beauties – Dormancy and resistance in harsh environments* took place at the Max Planck Institute for Molecular Genetics in Dahlem-Berlin, Germany during May 18-20, 2008. It included the following sessions:

- Dormant forms – entry into dormancy
- Quiescence and hibernation
- Survival in harsh and extreme environments
- LEA proteins and their association with dormant forms
- Ecological aspects of dormancy
- Germination and exit from dormancy
- Round table discussion: From dormancy to cell preservation

About 76 scientists and graduate students studying dormancy and desiccation in a wide array of organisms; from bacteria to hibernating mammals, including plant seeds and vegetative buds, presented results and held discussions. These will be summarised in a book to be published in 2009 by Springer and will enhance our knowledge of dormancy by identifying the molecular and cellular processes that enable organisms to enter and be revived from dormancy. ★
Have you ever wondered what happens when you die? At the University of Southampton in the UK researchers are engaging in a new project to get some answers on this, arguably the ultimate question.

The AWARE Project (AWAreness during REsuscitation) has been launched at the University of Southampton as part of the Human Consciousness Project and is the world’s largest-ever study of near-death experiences.

The study will be made up of an international collaboration of scientists and physicians who have joined forces to study the human brain, consciousness and clinical death. Dr Sam Parnia, an expert in the field of consciousness during clinical death, is leading the research along with Dr Peter Fenwick and Professors Stephen Holgate and Robert Peveler of the University of Southampton. Following a successful 18-month pilot phase at selected hospitals in the UK, the study is now being expanded to include other centres within the UK, mainland Europe and North America.

Dr Parnia explains, “Contrary to popular perception, death is not a specific moment. It is a process that begins when the heart stops beating, the lungs stop working and the brain ceases functioning – a medical condition termed cardiac arrest, which from a biological viewpoint is synonymous with clinical death.

“During a cardiac arrest, all three criteria of death are present. There then follows a period of time, which may last from a few seconds to an hour or more, in which emergency medical efforts may succeed in restarting the heart and reversing the dying process. What people experience during this period of cardiac arrest provides a unique window of understanding into what we are likely to experience during the dying process.”

Many recent scientific studies carried out by independent researchers have demonstrated that 10-20 per cent of people who go through cardiac arrest and clinical death report lucid, well structured thought processes, reasoning, memories and sometimes detailed recall of events during their encounter with death.

The AWARE study will be using sophisticated technology to study the brain and consciousness during cardiac arrest. In addition the researchers will test the validity of out of body experiences and claims of being able to ‘see’ and ‘hear’ during cardiac arrest.

The AWARE study will be complemented by the BRAIN-1 (Brain Resuscitation Advancement International Network - 1) study, in which the research team will conduct a variety of physiological tests in cardiac arrest patients, as well as cerebral monitoring techniques that aim to identify methods to improve the medical and psychological care of patients who have undergone cardiac arrest.

The current UK centres participating in the study include Southampton University Hospitals NHS Trust, Hammersmith and Charing Cross, St Georges, Mayday, Ashford and St Peter’s, Morriston (Swansea), Royal Bournemouth, Lister Hospital (Stevenage), Northampton General, and Salisbury Hospitals.

These will be joined by the John Radcliffe (Oxford) Addenbrookes (Cambridge), Great Western (Swindon), University Hospital Birmingham, James Paget University (Great Yarmouth) and East Sussex Hospitals.

Collaborators in the US include Indiana State University, Rosalind Franklin University of Medicine and Science, Drexel University, Brooklyn Medical Centre, the University of Virginia, Wayne State University and New York University; as well as Vienna General Hospital.
A FARA way for African agricultural development

To explore the history of FARA (the Forum for Agricultural Research in Africa) we have to start with the farmer. FARA is a publicly funded institution established to help improve the livelihoods of 100s of millions of resource poor African agricultural producers and consumers by improving farm productivity and competitiveness. The national agricultural research institutes were established to provide the new knowledge that those farmers need for innovation. That includes new varieties, husbandry techniques, markets, policy options and so on.

Acting alone the national institutes are not, however, well suited to dealing with issues like diseases and pests, and trade that cross national boundaries or in which neighbouring countries have common interests but on which it would be wasteful for each country to conduct independent research. This led to the formation of four sub regional organisations (SROs) for agricultural research that bring together neighboring countries in East, North, Southern and West Africa. The SROs have likewise found that there are issues which affect all sub-regions and on which a single African voice is most effective hence, they formed the Forum for Agricultural Research in Africa (FARA) to be the apex agricultural research institution for the continent.

However, FARA is not an implementing agency. FARA is a forum comprised of all stakeholders in African agricultural research and development. Its primary functions are to advocate for increased and better harmonised investment in agricultural research and to promote networking amongst our stakeholders to increase their collective impact in serving resource-poor African agricultural producers.

The smallholder farmer has a remarkable ability to innovate when given the opportunity. So we have to create the circumstances in which they can innovate. What we’re trying to do is help the agencies that provide the support that farmers need to function more effectively through collaboration and task sharing. Of course, European partnerships are extremely important to African agriculture. The European advanced research institutes have been in Africa for a long time and have skills and resources which are very valuable. We are collaborating with them in a novel programme called the Platform for African-European Partnership for Agriculture Research and Development (PAEPARD). We are trying to make African-European collaboration even more efficient than it has been in the past by creating an alternative to the one-on-one partnerships that were almost invariably European-led and largely supply driven. PAEPARD aims to be responsive to African research demands with leadership in any particular collaboration being provided by the appropriate party – be it European or African. We also want to ensure that where there is said to be African leadership, it is genuinely African having the best prospects of ensuring sustainability beyond the life of a particular project.

Africa is the continent that is furthest behind in meeting the Millennium Development Goals and FARA is most concerned about achieving MDG1 on reducing hunger and poverty and MDG7 on environmental sustainability. This is despite African economies having on average grown over five per cent a year for the past decade. That is not just due to high commodity prices, but also to improvements in agricultural productivity. However, Africa needs to have much greater progress if we are to get ahead of population growth. It is estimated that we need six per cent growth per annum if we’re to sustainably improve food security and reduce poverty amongst the African majority who are smallholder farmers and pastoralists.

The African leadership, in the 1980 Lagos Declaration were determined to break the reliance on imported development philosophies, which kept changing. So they created (in 2001) the African Union’s New Partnership for Africa’s Development (NEPAD), which is an arm of the African Union Commission focusing on economic and social development. The African Leadership’s recognition that agriculture must be the engine for the continent’s economic development is working to combine the strengths of all stakeholders in agricultural R&D in Africa, including European research institutions, as agriculture has to be the engine behind Africa’s economic development writes Ralph von Kaufmann
development led NEPAD to produce the Comprehensive Africa Agriculture Development Programme (CAADP) which is possibly the biggest experiment in agricultural development that Africa has ever undertaken.

The African Union Commission and NEPAD have appointed the FARA secretariat as the Lead Institution for the fourth pillar of CAADP, which covers agricultural research, technology development and dissemination with crosscutting capacity strengthening. In that capacity we spearheaded the development of the Framework for African Agricultural Productivity (FAAP), which was approved by African Heads of State and Government in Banjul in 2006. FAAP sets out how research should be conducted for optimal, equitable and sustainable impact. It provides guidance for the evolution and reform of agricultural institutions and services, for increasing the scale of Africa’s agricultural productivity, and of aligned and coordinated support. This is a key product from FARA’s early years.

FAAP may sounds like a large-scale initiative but it’s more a set of principles and guidelines, and we’re trying to promote adherence to them. The argument is that if a proposal for funding, or a proposed activity that is presented at CAADP roundtable negotiations, follows those principles it will be a better project. It fits in with the Paris Declaration on aid effectiveness which calls for better coordination and harmony in development funding – we want better quality money, as well as more money.

The most effective stimulus for agricultural productivity is the availability of a viable market. To bring that about we have to attend to the needs of the smallholders. Bigger farmers have a part to play, especially in providing a source of improved germplasm but also in validating new technologies, opening markets and providing on the job training, but it’s the smallholders who are in the majority and produce most of the food. The African woman farmer is the key target – and above all she needs to be able to sell her products. Effective markets require enabling policy environments and good communications, transport and storage facilities that reduce the transaction costs. The lack of these presently cripples agricultural trade in many parts of Africa causing famine and un-saleable surplus produce to co-exist, even the same country. In the past there was a focus on telling people what they should be doing but it is not possible to learn farming from pamphlets, radio broadcasts and the like. Farmers have to be able to ask questions and to build on their own ethnic and tacit knowledge. We need to back up the provision of information with empowering the end users to ask questions and learn i.e. to become more knowledge-able. Modern techniques and distance learning capacities bring huge advantages in this regard, which haven’t been taken advantage of yet. There is a lot we can learn from South Asia on how to promote rural learning communities and life-long learning.

Exploiting Africa’s potential

Information Technology is vital because we will never have an extension service capable of reaching every farmer. We’ve seen in several African countries such as Kenya and Senegal how the mobile phone is becoming an important instrument, particularly for getting market data and finding out who’s got what to sell and what the prices are in...
The umbrella organisation FARA holds a meeting on creating sustainable resources

different places. This is advancing rapidly in Africa, which is the World’s fastest growing market for mobile telephony.

We’re very encouraged by the fact that African agricultural productivity is improving. It’s no longer the continent where people are always becoming worse off but I don’t think Africa is getting the credit it deserves for the progress that it has made. However, we need to take ambitious and bold actions to develop our human and institutional capacity. Failure to develop our full human potential is the biggest constraint to rapid development. Meanwhile, the whole world is coming to us for our abundant natural resources. Whenever there is an IPO it is over subscribed so money too is not an immediate constraint. Ghana was ahead of Korea at independence and South Korea has faced the same political problems as Ghana but has made much better investments in infrastructure and capacity – and look at the difference – South Korea now has 10 times the per capita GDP of Ghana.

Africa has been very successful in increasing the number of places at universities, by both expanding the existing universities and building new ones. But what it hasn’t done is kept up with the budget and resources for those universities. So they have lost many of their best faculty members and those who valiantly remained have had to run to stand still, often with large classes and poor facilities. Too many are still practicing talk-and-chalk teaching rather than promoting learning. In some the term ‘theoretical practical’ has been coined to cover the lack of resources for the students to conduct hands-on experiments. This should not and does not have to be accepted. African universities have developed a pragmatic proposal, in which they welcome European partner universities and the African agricultural research community to revitalise tertiary education in agriculture taking advantage of modern training and learning approaches and techniques.

The negative impressions of Africa are quite a challenge because they take a long time to change after the causes have been removed. It is also difficult for agriculturalists to grab the headlines with success stories which are so much less emotionally appealing than pictures of poverty and famine. We’re trying to create a more positive image based on the truth that African agriculture has been and will continue to be a good investment. And the fact that developing Africa is absolutely in the best interest of the world – there are enormous untapped resources in Africa, and improving our utilisation of them will have a big impact on the world as a whole. The prevalent low yields on African farms is, perhaps ironically, the greatest opportunity for increasing food production in comparison with countries where the gap between actual and potential yield is closing. Taking rice as an example Africa has 200 million hectares of suitable land and yields could be doubled or even tripled. If the world wants more rice then Africa could produce it. If the world wants Africa to conserve the planet’s second largest rainforest and greatest reservoir of biodiversity it must help Africans break their reliance on expanding cultivated land to produce more food. If the world wants to reduce the largest population of internally displaced persons who are the subjects of conflict and unwanted emigration it must help Africa increase food production.

At a glance

FARA’s vision
Reduced poverty in Africa as a result of sustainable broad-based agricultural growth and improved livelihoods, particularly of smallholder and pastoral enterprises.

FARA’s mission
Creation of broad-based improvements in agricultural productivity, competitiveness and markets by supporting Africa’s sub-regional organisations in strengthening capacity for agricultural innovation.

More Information
FARA is the Forum for Agricultural Research in Africa, the apex organisation bringing together and forming coalitions of major stakeholders in agricultural research and development in Africa.

Dr Monty Jones
Executive Director of the Forum for Agricultural Research in Africa

Dr Monty Jones is a breeder by profession and currently the Executive Director of the Forum for Agricultural Research in Africa based in Ghana. He is co-winner of the 2004 World Food Prize for the development of the New Rice for Africa (NERICA) which is the interspecific progenies bred by traits of the traditional robust African rice varieties. Dr. Jones is also the recipient of other awards including an honorary Doctor of science degree from the University of Birmingham, Insignia of the Grand Officer of the order of the Rokel from Sierra Leone, National Order of Merit of Cote d’Ivoire and was associated with the King Badouin award given to WARDA by the CGIAR. He has been listed as one of the 100 most influential people in the world by the Times in 2007.

The umbrella organisation FARA holds a meeting on creating sustainable resources
Thematic Priorities

- ICT for Networked Enterprise
- eGovernment & eDemocracy
- eHealth – Services to Citizens
- Collaborative Working Environments
- Digital Libraries and Cultural Heritage
- Intelligent Content and Semantics
- Networked, Smart and Virtual Organisations
- Security and Identity Management
- Technology Enhanced Learning and ICT Skills

Submission of Papers

Paper Focus - technical, visionary, business or government case studies
Papers must highlight level of innovation and actual or expected impact
Either a case study, initial or final results must be presented
Initial submission - Extended Abstract of 800 - 1,200 words in length

Online Submission Deadline - 28 February 2008

Sponsorship Opportunities

- Support Brand Identity & Build Relationships with Leading Government, Industry and Research Organisations from around the World
- To Discuss a Standard or Customised Package, Contact secretariat@eChallenges.org

Supported by
Europe is keeping pace with change and concentrating on new efforts to re-charge the batteries of the Lisbon agenda and re-energise innovation accordingly. In this context, Simon Jones, Operations Director for British Publishers wants to put EU funded projects in control of their publishing needs.

There are signs of a renewed dynamism in Europe’s approach to achieving the goals of the Lisbon Agenda. For one there has been another Aho report (put together by former Finnish PM, Mr Esko Aho and his expert panel), this time outlining what is needed in the area of HI-tech research in Europe to make it more effective and Commissioner Viviane Reding is fast to call this document a “wake-up call” for all concerned. Secondly, there is the creation of the EIT, an institute that will act as a flagship for linking education with research and innovation and finally commercialisation. Links between further education and quality R&D should be nurtured well if the goals of the Lisbon Agenda and the growth in jobs and industry that it expects are to be realised.

Keeping Europe’s goals alive
Europe’s dream of supreme development and enrichment is under constant attack from market forces and an increasingly hostile environment from not just rising external economies but from imploding internal ones. To keep the foot on the preverbal ‘accelerator’ we have to really pull together, understand the enormous challenges that face Europe and tackle them with an educated, wise eye, not being distracted by quick-fixes and false starts that are typical of many large scale European endeavours. We need to concentrate on what is important, cut through some of the red tape that trips up exciting projects and innovation and put money into projects with sustainable development aims so the money comes back in to Europe in one way or another. Innovation is the key to development, but to give innovation the breathing room it needs we have to be brave, be conscious of linking complimentary areas, for instance education with research with innovation. We have to supply the perfect environment to grow R&D in terms of scale and quality.

Dissemination
On a vital last note we need to get the projects that are chosen for funding out into the world, get them noticed by the right people at the right time, get them networked and seen. That is a job that British Publishers and this very magazine you are holding in your hands can accomplish.

We have partnered in dissemination campaigns with some of the leading and most important European projects and we are rightly proud of our achievements and history in this role to date.

We can organise a package which involves coverage in this publication that goes out to our unique and valued readership and also to some of the world’s biggest events relevant to dissemination needs, or we can go further and take care of all your project’s dissemination requirements in a tailored package.

If you would like to know more about what British Publishers can achieve for your R&D project and some of the options and packages available to help you get the most from your FP7 dissemination package, contact me on +44 117 9166537
Our dissemination has been significantly aided by involvement with British Publishers and eStrategies and it has helped us to reach an audience outside our usual scientific community.

Jaques Warnier, Head R&D
Yageo Europe B.V.

Let British Publishers take care of your communications strategy and make sure your project gets the publicity it needs for effective knowledge transfer.

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If you are interested in learning more about how British Publishers can work with you in optimising your communications strategy for your R&D project, please call Operations Director Simon Jones +44 (0)117 916 6537 or email sjones@bpl.uk.com
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