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POLISH PRESIDENCY SPECIAL ISSUE

Secretary of state for European affairs Mikołaj Dowgielewicz on how Warsaw aims to put the EU back on track towards economic prosperity

"Over the course of the next six months, we Poles will attempt to return to Europe some of the positive energy we ourselves have received from it"

In Pole position
Poland's presidency priorities with Jerzy Buzek, Jacek Saryuz-Wolski, Danuta Hübner, Jan Olbrycht and more

Plus
Icelandic diplomat Stefán Haukur Jóhannesson on Reykjavik's EU accession bid

Life at sea
Maria Damanaki on European maritime policy, Alyn Smith on marine energy, Veijo Huusko on wave power and more

Plus
Malcolm Harbour on toy safety, Anni Podimata on a financial transaction tax

INSIDE:
The Parliament Magazine's RESEARCH EUROPEAN RESEARCH & INNOVATION REVIEW
p109

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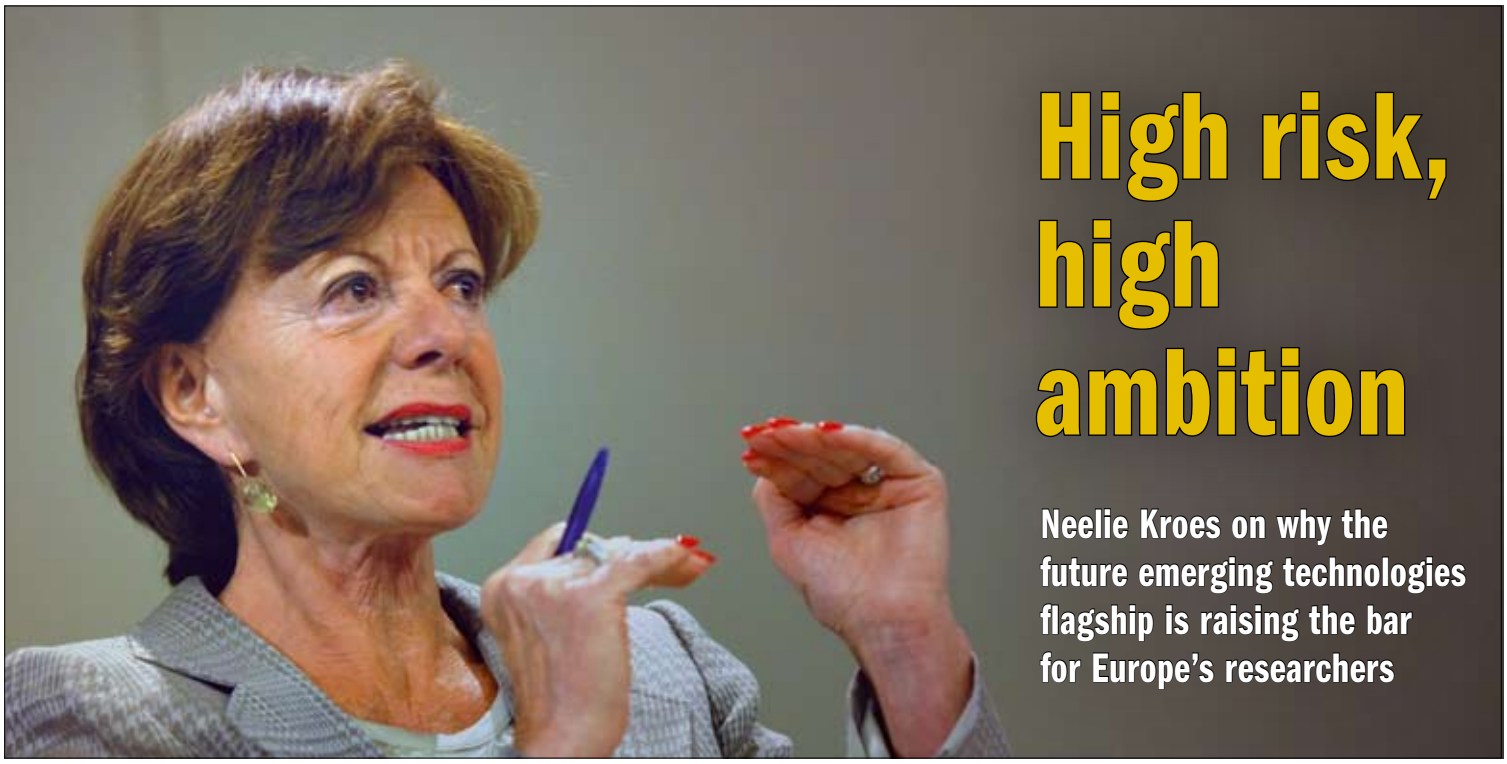


High risk, high ambition

Neelie Kroes on why the future emerging technologies flagship is raising the bar for Europe's researchers

RESEARCH ROUND-UP

SMART THINKING

POLICY PROGRESS

High risk, high ambition

The future emerging technologies flagship will help the EU make the most of its researchers' talents, writes Neelie Kroes

Europe needs to work together in the face of global competition. The financial crisis has slashed government budgets across Europe. I believe that "doing more with less" for improving productivity is a key response to solve the challenges that we face. This applies especially to information and communication technologies (ICT) research, a key contributor to European competitiveness. Investments in ICT account for 50 per cent of all European productivity growth. Supporting "riskier" research that is instrumental to emerging technologies and new business breakthroughs is therefore a key element of the digital agenda for Europe.

Europe has some of the world's brightest researchers in its labs. We need to make the most of their talents. The future and emerging technologies (FET) flagships can help us do exactly that by giving Europe's best scientists the opportunity to deliver major breakthroughs and have an impact on the way our lives will look in the future.

FET is the incubator and pathfinder for long-term research in ICT. We need new ideas and we need to venture into uncharted areas to go beyond the conventional boundaries of ICT. For instance, graphene is a new material that could replace silicon as the wonder material of the 21st century. Asia and America are investing hundreds of millions of dollars in this material –Europe cannot afford to ignore this technology, nor the economic importance of research in this field.

For this very reason, in 2010, the commission invited scientists to identify future grand scientific challenges with high potential impact on science, economy and society and to propose projects. From the 21 proposals received, an expert panel selected six pilots with the strongest potential for achieving scientific breakthroughs. Next year, two of them will be selected for long-term funding that will run for 10 years, each with a total budget of up to €100m per year. That funding will come from a mixture of sources, including private and member state investments. The two projects will then be launched in 2013.

But one thing is clear, cooperation between scientific disciplines is essential to make the FET flagships a success. New interdisciplinary approaches are necessary to tackle problems that cannot be solved by conventional research efforts. For instance, mapping the human genome involved hundreds of scientists from across the globe and a lot of investment to bring them together. That's why close cooperation between national and EU research programmes is essential. Only the global dimension of these flagships will foster European leadership and excellence in frontier research.

"FET flagships have the potential to provide solutions to some of society's largest challenges and benefit our economy"

FET flagships have the potential to provide solutions to some of society's largest challenges and benefit our economy. For instance, little is known today about how the brain actually works, making effective treatment for brain diseases difficult or impossible in many cases. The human brain project flagship aims to understand how the human brain functions as detailed knowledge would aid the development of better therapies for patients suffering from illnesses such as Parkinson's or Alzheimer's disease. Another flagship project - graphene -aims to drive forward the development of graphene electronics. This is widely recognised as one of the most likely and attractive solutions for sustaining the evolution of ICT devices and technologies beyond the limits of silicon. The flagship would create novel electronic components with ultra-fast operational speeds. Carbon has already been the driving force behind several technological revolutions such as energy production and plastics and it could potentially place Europe's microelectronics industry at the heart of innovation. Another flagship - FuturICT - aims to develop the most sophisticated computer simulator in the world to capture everything that happens on our planet. It would explore social life on earth, analyse information on a global scale and provide a basis for predicting natural disasters and enabling more informed crisis management.

Apart from the impact and the benefits that the flagships can deliver to Europe's economy and society, I also believe they will have a positive impact on the research landscape in Europe. The long term nature of these ambitious research pilots should attract scientists to come to the EU from across the globe to work in Europe's best labs, contributing to a reversal of the "brain drain" of the past. The FET flagships will provide much needed opportunities for highly trained researchers to continue their work in Europe with the prospect of a long term career. I look forward to launching the two FET Flagships in 2013. I have no doubt that they will plant the seeds for tomorrow's innovation. ★

Neelie Kroes is commission vice-president for the digital agenda

Carbon revolution

Graphene has the potential to make Europe a leader in a smart carbon revolution, writes Jari Kinaret

Europe needs visionary initiatives that express and channel our common dreams, while invigorating imagination beyond the imaginable. Europe also needs concrete projects with realistic output, likely to foster higher employment rates and better quality of life.

A coordinated scientific action on graphene is truly visionary, yet both concrete and realistic. An EU future emerging technology flagship aimed at a breakthrough for technological innovation and economic exploitation based on graphene and related two-dimensional materials would reinforce Europe's hightech position in information and communication technology (ICT) and competitiveness in general.

Graphene, a single layer of carbon atoms, may be the most amazing and versatile substance available to mankind. Stronger than steel, yet lightweight and flexible, graphene enables electrons to flow much faster than silicon. It is also a transparent conductor, combining electrical and optical functionalities in an exceptional way.

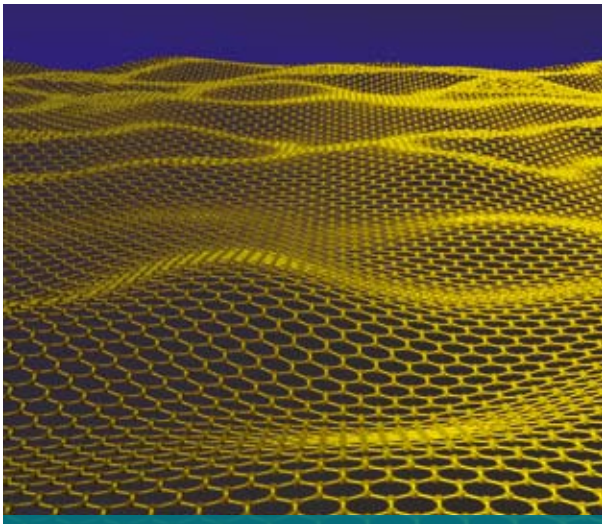
Graphene can trigger a smart and sustainable carbon revolution, with profound impact in ICT and everyday life. Its unique properties are spawning innovation on an unprecedented scale and scope for high speed, transparent and flexible consumer electronics; novel information processing devices; biosensors; printable electronics; supercapacitors as alternatives to batteries for cars and portable appliances, and ultralight composites for cars and planes.

The groundbreaking experiments on graphene in 2004 by European scientists Andre Geim and Konstantin Novoselov were awarded the 2010 Nobel Prize in physics. Their work has sparked a scientific explosion, best illustrated by an exponential growth of publications and patent applications related to graphene. Huge amounts of human resources and capital are being invested into graphene in the US, Japan, Korea, Singapore and elsewhere. The first products are expected to enter the market by 2014.

Individual European research groups pioneered graphene science and technology, but Europe's efforts are still fragmented. A coordinated European level approach is needed to secure a major role for the EU in this ongoing technological revolution. The graphene flagship aims to bring together a large, focused, interdisciplinary European research community, acting as a sustainable incubator of new branches of ICT applications, ensuring that European industries will have a major role in this radical technology shift.

The graphene flagship already includes over 200 research groups, representing 80 academic and industrial partners in 21 European countries. The scientific board holds four European Nobel laureates and key representatives from Korea and the US, sharing the view that this high risk initiative quickly could translate into industrial growth. Carbon is an abundant resource, not least in Europe. European manufacturing of graphene could offset the need for scarce metals from remote mining areas, like indium that today is vital for electronics production such as touch screens.

But this requires a series of scientific breakthroughs on a scale that no single country or industry can achieve on its own. A flagship can make this happen. It can communicate this vision to industry and the public and even raise interest for science and technology among young people. It could be the formula to put an end to the European paradox. Carbon has already been the driving force behind two technological revolutions: energy production in the 19th century and plastics in the 20th century. Now carbon promises a third revolution, this time in ICT. A graphene flagship would place Europe's electronics industry at the heart of innovation. In this context, €1bn is a good deal. ★



"A coordinated European level approach is needed to secure a major role for the EU in this ongoing technological revolution"

Jari Kinaret is a professor at Chalmers university of technology and is coordinator for the graphene-CA project

Guardian Angels

Many of the world's problems associated with welfare and demographic change could be dealt with by the Guardian Angels project, writes Adrian Ionescu

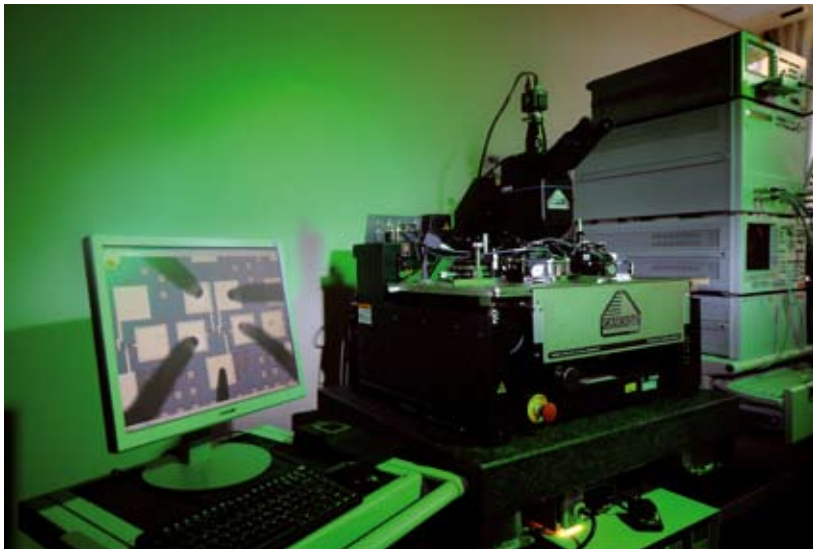
The goal of the future emerging technologies flagship pilot "Guardian Angels for a smarter life" is to develop enabling technologies for digital personal assistants. These devices, envisioned as energy-efficient, intelligent, autonomous systems-of-systems, will guard our safety and monitor our wellbeing. They feature sensing, computation, and communication with characteristics well beyond human capabilities.

Ultimately, it is intended that these personalised and customisable devices, as our modern day guardian angels, so to speak, will provide assistance from infancy right through to old age. They could assist, for example, elderly people to maintain their quality of life, even in the case of a continuous reduction of mobility and cognitive abilities. They could help individuals to prematurely recognise environmental threats and dangerous situations. And they will feature a wireless networking capability to increase the information database far beyond the radius of action of the individual.

Our technology platform will create the ultimate smart device that everyone will be able to benefit from. Some of the main applications of Guardian Angels will be centred on concepts of prevention of harm in areas like biomedical and security, but also on smart advice based on sensor fusion and inter-device communication. It is further envisioned that these personal companions directly interact with the human neurological system to allow for man-machine interfacing for disabled persons. The device will enlarge the cognitive abilities of individuals and will provide access to a useful augmented reality while preserving full control by the individuals of their Guardian Angels and a high degree of security of information.

"Our technology platform will create the ultimate smart device that everyone will be able to benefit from"

Adrian Ionescu is coordinator for the Guardian Angels project at the Ecole Polytechnique Fédérale de Lausanne

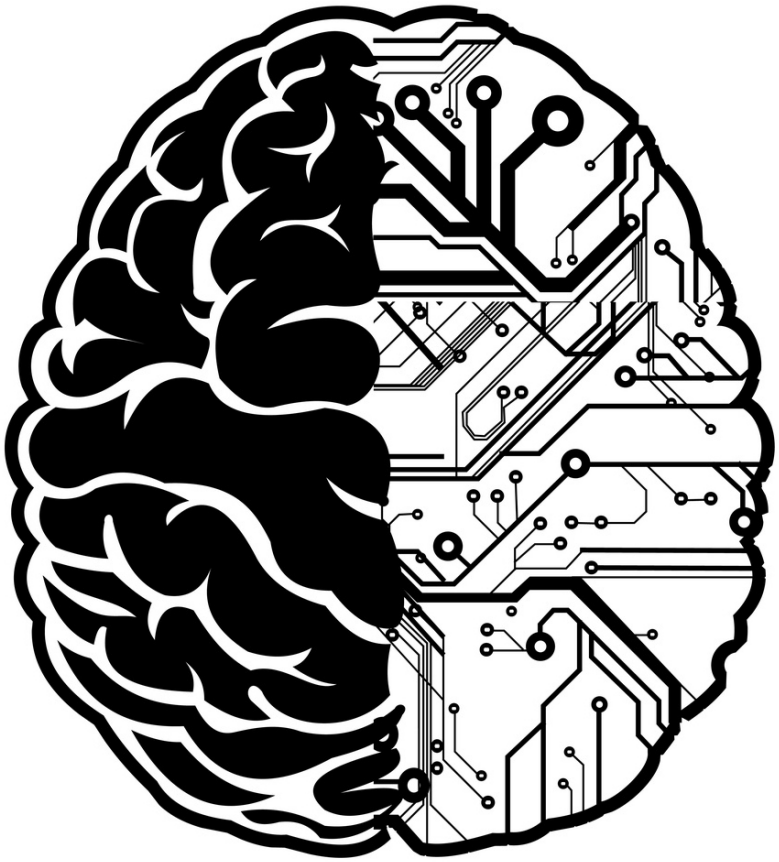


For these applications, the Guardian Angels device will have to be small, intuitive to use, comprise a multitude of sensor and communication functions – and foremost, achieve all its functions with an absolute minimum of energy consumption. The scientific and technological challenges of the Guardian Angels project are thus related to the development of a full ultra-low energy innovation chain from materials and devices, to the heterogeneous system integration, as well as software and communication techniques enabling drastic energy consumption reduction compared to existing state-of-the-art technologies.

Moreover, a central feature of Guardian Angels is the zero power requirement. The devices will scavenge for energy in very diverse environments. Therefore, disruptive scientific progress is needed in the field of novel concepts and technologies for energy harvesting, such as solar, thermal, movement, electromagnetic, to propel European research forward in the next 10 years. Christofer Hierold of ETH Zurich, co-project leader, says, "We will focus our research on high energy efficient systems – but at the same time it is vital to develop ecologically as well as economically sustainable sensors."

The high complexity, key functions and enabling technologies envisioned in this project are unique and go beyond any system complexity that has been achieved so far. The goal of the Guardian Angels flagship is to demonstrate the feasibility and functionality of systems-of-systems, by visionary concepts and targeted research towards centred on applications dealing with the concept of a smarter life. ★

Joined up thinking



Accurate mapping of the human brain will provide the first step towards a new foundation for research and medical treatment, writes Henry Markram

Every year, 135 million European citizens are affected by diseases of the brain with annual costs to the European economy that could well be more than €700bn. The pharmaceutical and biotechnology companies that used to fund 95 per cent of brain research are pulling out. The number of new patents for brain-related drugs and brain prosthetics drops every year.

Even before industry reduced its investment, it was focusing on just a handful of diseases, with the majority remaining unexplored. Meanwhile, it has left basic research to academia. The result is a huge volume of fragmented knowledge. Without a strategy to put the pieces together, we will never find the answers we need.

One radical solution is to integrate everything we know in detailed computer models, flexible enough to incorporate the rising flood of data and knowledge from neuroscience research. In this "integrative" strategy, we pool experimental and clinical data from all over the world, look for patterns, and use them to understand basic rules of brain design. We then use the rules to model the brain avoiding the need to measure every single neuron, synapse, molecule, and gene. Many rules are valid across species. Using them allows us to model the human brain without invasive experiments to collect data.

What we are trying to do is like building a new scientific instrument, a special kind of telescope. Every time we use the instrument, we learn more about the brain, and everything we learn helps us improve the instrument, until it gives us a full and comprehensive picture of the way the brain works. Scientists will use it to test their hypotheses about the causes of brain disease - not just the lucrative ones, but any disease that interests them. It will give them new therapeutic leads, and a cheaper, faster and non invasive way of testing them. It will allow them to simulate new kinds of brain prosthetics for disabled people, and help them to produce better diagnostic tools, and better treatments. The end result will be better lives for patients and lower health costs.

A few years ago all this would have been unthinkable. What makes it feasible is the enormous progress of modern supercomputing. Today's most powerful machines can perform a million billion calculations per second. By 2018 that will reach a billion billion - more than enough to build realistic models of biological systems. Before building can begin, biologists will have to move beyond simple conceptual models and computer engineers will have to design a new generation of supercomputers, but the plans to do so are already in place and the new instrument is within sight. Though it will not be a panacea, it provides a new foundation for research, an essential first step towards the new treatments we desperately need.

In reality it can offer far more than this. What we are proposing is a completely new kind of simulation-based research with a huge range of applications. Already scientists are planning to use it for "neuromorphic computers" – a new generation of intelligent technologies. But that is another story. ★

"What we are proposing is a completely new kind of simulation-based research with a huge range of applications"

Henry Markram is coordinator for the Human Brain Project at the Brain Mind Institute, Ecole Polytechnique Fédérale de Lausanne

Artificial assistance

Europe's ageing population requires a technological solution that will provide its citizens with key services, assistance and independence, writes Paolo Dario

Current welfare is not without challenges and its sustainability is at stake in a number of environments: private, social, economic, urban and physical. A major critical challenge affecting welfare is the ageing of the population. In fact, in 40 years nearly 35 per cent of the European population is projected to be 60 years old or over, hence the urgency to provide solutions enabling an ageing society to remain active, creative, productive, and, above all, independent.

To solve problems in the real world one has to act in the real world. We envisage that to sustain the quality of life of the ageing population, we require a new class of machines and linked technologies, namely the robot companions for citizens. The robot companions (RCs) will be a new generation of machines representing a true quantum leap compared to current robotic systems: RCs will be the affordable, sustainable, fully recyclable and dependable key enabling technology for the foundation of a new sustainable welfare. RCs will be able to perform a multitude of assistive roles for humanity thanks to their capabilities to act and interact physically, emotionally, socially and safely with humans in daily activities in their workplace, at home and in society. RCs will be ubiquitous, yet unobtrusive and user-friendly. This new generation of robots will extend the active independent lives of citizens, bolster the labour force, preserve and support human capabilities and experience. Also, RCs will provide key services in our cities, aid us to cope with natural and man-made disasters, maintain our planet, and will enable a number of derivative applications.

We envisage the robot companions being able to help an old bricklayer who is still productive and willing to work, to build a stone wall or fabricate a concrete block, perform house work, or retrieve and transport objects.

To this aim, the FET flagship candidate "robot companions for citizens" (RCC) proposes a transformative initiative addressing an across-domain grand scientific challenge. We will unveil the secrets of the embodied perception, cognition, and emotion of natural sentient systems that make them capable of acting, interacting and adapting effectively to their physical and social environment and of being cognisant and sentient of this relationship to the world.

> ***"To sustain the quality of life of the ageing population, we require a new class of machines and linked technologies"***

The grand scientific challenge of the RCC initiative requires and will foster an advanced understanding of the principles underpinning the mind-body, or structure-function, relationship –or the role of "matter" in building the mind, the principles of neuroscience, and the principles that make living beings cognisant and sentient. This vision relies on the idea that robotics becomes a platform for science-grounded investigations and an active technology provider rather than a passive technology user. This will involve systematic and federated contribution and continuous involvement of several disciplines and communities, including nanotechnologies, material science and tissue engineering for a new bodyware.

Biomaterials, and micro and macro-scale cell biology, for developing bioartificial hybrid systems; nanofabrication technologies for energy storage, production and harvesting will also be used. Neuroscience and the organising principles of the sensory-motor system; systems of neuroscience for understanding the design principles of brains and the processes that allow their evolution, development, adaptation and maintenance in the real world are crucial. Also being factored in are social neuroscience, cognition and principles of human-human, human-robot and robot-robot interaction; principles of knowledge accumulation and expression; human and social sciences to favour the social acceptability of the robot companions and facilitate their coexistence with humans, with attentive analysis of any potential ethical and legal implications. ★

Paolo Dario is professor of biorobotics and director at the Institute of Scuola Superiore Sant'Anna, Pisa, Italy and coordinator of the CA-RoboCom pilot FET flagship initiative