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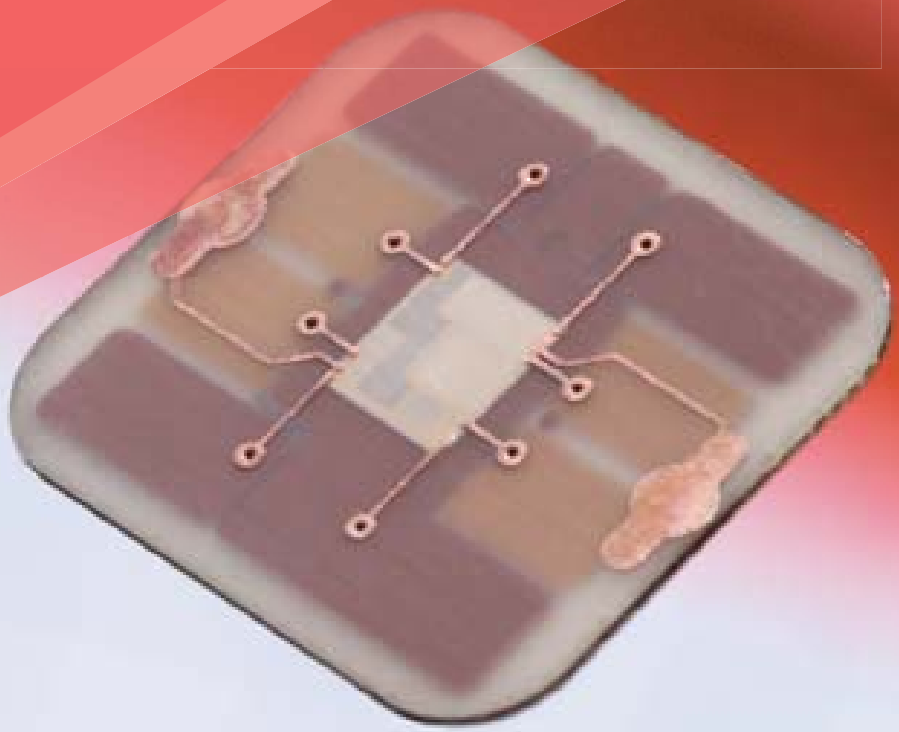
ICT Research
The policy perspective



ICT and innovation
From micro-chips to macro-solutions

European Commission
Information Society and Media

This brochure has been produced for the Information Society Policy Link (ISPL) by the ICT Results editorial service. ISPL is an important part of the Information Society and Media Directorate-General's goal to draw clear lines between policy, policy-making and European research in the field of information and communications technology (ICT).

ISPL publications and other news are available via the website:
http://ec.europa.eu/information_society/activities/policy_link/

ICT Results is an online editorial service established on behalf of the Information Society and Media Directorate-General.

The service's main aim is to:
- raise the visibility of ICT-funded research results
- support projects' access to markets and encourage uptake of innovations
- raise awareness of European ICT programmes and activities

ICT Results website: http://cordis.europa.eu/ictresults

Lead or be led, but the future's digital

In this report produced for the publication series ICT Research: The policy perspective, we examine how information and communications technology, or ICT, plays a pivotal role in driving innovative solutions to business, government and societal issues. ICT is essential for innovation, by which Europe can successfully compete in the global economy.

It is easy to see how some inventions have changed the world: Gutenburg's printing press, Newcomen's steam engine, the telephone, the microchip. New technologies can reshape society and industry; they let people find new ways to do business, new ways to interact and improve the quality of their lives.

Societies are not just revolutionised by novel gadgetry. Sometimes changes in the way we do things or the way we think can also have a massive impact. You only have to witness the current growing concern about corporate responsibility to see how shifting attitudes are rewriting the modern rules of business.

The development and implementation of new technologies, new ideas, new processes and new paradigms are all part of the important process of innovation – a process that is fundamental to maintaining Europe's competitive position in the global economy.

Innovation may spring from Eureka moments, but it very often needs the right environment – in research settings and outward to the business world – to benefit society fully. This is where the European Union takes its lead with policies and funding to help researchers and budding entrepreneurs convert ideas into new technological innovations, from quieter jet engines to nano-robots. Inventive combinations of existing technologies and changes to working practices can also stimulate innovation and economic growth, especially through innovations in services.

Innovative policy-making, too

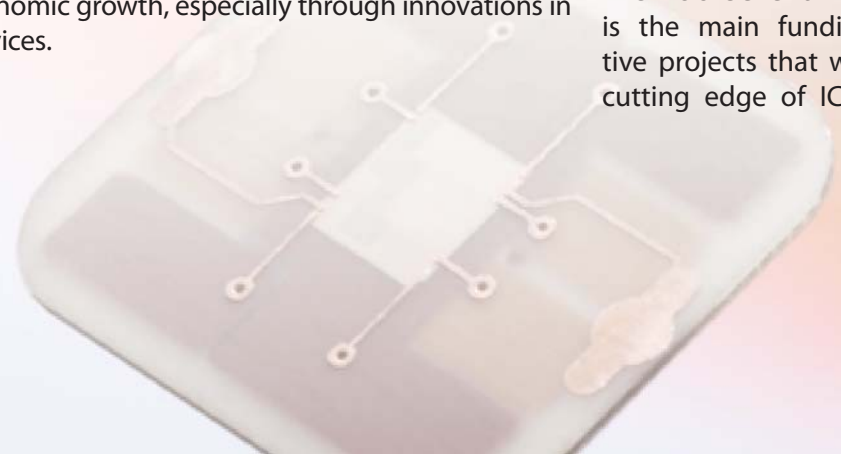
The EU's renewed **Lisbon strategy** for growth and jobs is quite clear about the importance of innovation. During the 2006 and 2007 Spring European Councils, Member States agreed that investing more in "knowledge and innovation" should be one of four priorities aimed at reaching the Lisbon goals.

EU leaders have agreed that, by 2010, the EU as a whole should invest 3% of its GDP on research and development. But to boost the economic return on this investment it is critically important to improve the transformation of research findings into innovative products and services – getting knowledge from the lab onto the marketplace.

This focus on European innovation is outlined in the European Commission's Communication on innovation '**Putting knowledge into practice**: A broad-based innovation strategy for the EU' (September 2006). According to this document, "the Commission is convinced that innovation in a broad sense is one of the main answers to citizens' material concerns about their future."

The **i2010** initiative sets the strategic framework for ICT policies in the EU. It promotes the positive contribution that ICT can make to the economy, society and personal quality of life. Recognising the bespoke impact of ICT, i2010 aims to strengthen innovation and investment in ICT research whilst also supporting inclusion, better public services and quality of life through the use of ICT. The impact of ICT and e-business on enterprises, industries and the economy in general is being assessed by the "Sectoral e-Business Watch".

The EU's **Seventh Framework Programme** (FP7) is the main funding instrument for collaborative projects that will ensure Europe stays at the cutting edge of ICT research and development.



Under FP7, ICT has a total working budget of €9 billion. The bulk of the research activities sets out to meet seven 'Challenges' of strategic interest to European society:

- **Challenge 1** - Pervasive and trusted network and service infrastructures
- **Challenge 2** - Cognitive systems, interaction and robotics
- **Challenge 3** - Components, systems and engineering
- **Challenge 4** - Digital libraries and content
- **Challenge 5** - Sustainable and personalised healthcare
- **Challenge 6** - Mobility, environmental sustainability and energy efficiency
- **Challenge 7** - Independent living and inclusion

Europe's leadership in certain fields of ICT-related R&D is particularly bolstered through a public-private R&D initiative, known as **Joint Technology Initiatives** (JTIs). JTIs combine private-sector investment and national and European public funding, including FP7 grants and loans from the European Investment Bank. Two JTIs in the areas of nano-electronics and embedded computing systems, have been launched.

Get down to business

Europe's excellence in ICT research is only part of the story, however. It is not enough to shrink microelectronics down to the nanoscale, or develop cheaper manufacturing methods for mass-produced optical switches. Innovative ICT must be disseminated, implemented and applied to innovative activities.

A new EU programme aims to support this process. The **Competitiveness and Innovation Programme** (CIP), aimed specifically at SMEs, will run in parallel with FP7 and help businesses to apply research findings and improve their competitive advantage.

As part of CIP, the **ICT Policy Support Programme** (ICT PSP) has a total budget of €730 million. It aims to stimulate innovation and competitiveness through the wider uptake and best use of ICT by citizens, governments and businesses by funding pilot trials of new technologies and thematic networks.

Dedicated EU initiatives, such as **PRO INNO** and **Europe Innova**, are also receiving support from the CIP to analyse and benchmark the best ways to nurture and grow Europe's "innovation potential".

ICT: innovative technology, or technology for innovation?

Information and communications technology has a dual role to play in Europe's ambitions. On the one hand, the field of ICT development is highly innovative itself. Each year, microchips get smaller, computers more powerful, and communication between devices more widespread. It is essential that the EU benefits from this lucrative market and has every opportunity to be at the forefront of significant ICT breakthroughs.

On the other hand, ICT has become a must-have tool. Computers, mobile phones and the internet, for example, have transformed almost every aspect of our lives, from the way we do business to how we interact with our family and friends. ICT provides a foundation for innovative business, healthcare and education. Whether it is e-Government or e-Health, the deployment of ICT opens up exciting new ways for governments, industry and individuals to interact with one another more effectively, safely and transparently.

Meeting the challenges

For Europe to remain a competitor in the global economy, its leadership in ICT technology cannot be compromised. The work of the nine existing ICT **European Technology Platforms** (ETPs) has helped to formulate strategic research agendas in their respective fields.

Using input from these ETPs and other sources, the **ICT Work Programme 2007-2008** identifies three overriding research goals: convergence of communication and service infrastructure; more robust, context-aware systems that self-improve and self-adapt within their respective environments; and smaller, cheaper, more reliable components and systems. These particular technical challenges cut across all of the seven ICT themes of FP7; R&D projects are providing technologies to drive innovation and greatly improve the competitiveness of business and the quality of life of European citizens, *as illustrated below*.

ICT in healthcare

The application of ICT in healthcare is changing how medicines are discovered and developed, how diseases are diagnosed and the way in which treatments are delivered. From electronic health records to telemedicine, medical implants to genetic screening, ICT is helping to make Europe's health systems deliver better, more cost effective care. Convergence is particularly important, for instance to improve personal health monitoring, whereby implants can transmit and receive data wirelessly, but healthcare workers can access the information online or be alerted on a mobile device in an emergency. Next-generation medical implants will also depend on the miniaturisation of electronics and novel power sources.

Broadband access

The internet is now an everyday tool for most European citizens; businesses, public administrations and organisations, large or small, cannot ignore their e-services. ICT can greatly facilitate client communication and collaboration, customer contact, or the delivery of a product or service. But most innovative online services today eat up significant bandwidth; fast broadband access is all but a standard requirement for online applications. However, rural and remote communities, particularly those without a telephone line or too far from a telephone exchange, may find broadband internet inaccessible. New ways of delivering affordable broadband must be researched and deployed.

Miniaturisation

In 1965 Gordon E. Moore, co-founder of Intel, noted that the number of transistors you can fit into an integrated circuit appeared to double about every two years. Moore's law still holds true today, such that electronic components are beginning to shrink to beyond the scope of the human eye. But the advent of the "nanochip" is not a given. Novel ICT that relies on microscopic components will only be possible if R&D can develop new fabrication techniques to mass-produce the new generation of electronics at an affordable price.

Embedded systems

Everyday items are getting smarter and smarter. As microchip technology gets smaller, cheaper and more powerful, it is no big deal to embed ICT into everything from cars to clothes. However, more research is required into the programming and interactions between these devices, for example in systems designed to prevent car collisions. Then it will be down to innovative manufacturers and marketers to convince us about the benefits of health monitors in our garments, personalised networks of devices – or digital fridges and online armchairs!

© Healthy Aims

Life support for European healthcare

Effective healthcare is essential for improving the quality of life for European citizens. A series of EU-funded projects seeks to ensure that the functionality of leading ICT systems is incorporated into innovative approaches to the entire healthcare value chain.

Medicine and healthcare is an ancient art. Yet since its earliest days, people have benefited greatly from pioneering approaches, groundbreaking surgery and careful, insightful research. From Harvey's description of the double circulatory system to Barnard's first heart transplant, medicine has progressed to a point where the absence of disease and longevity have become increasingly commonplace for European citizens.

In the past couple of decades, healthcare has taken a leap forward, thanks to computing and ICT technology. ICT provides powerful tools throughout the entire healthcare value chain, from the earliest stages of drug discovery to the delivery of therapies to patients.

e-Health is emerging as the new 'industry'. By 2010, e-Health spending may account for up to 5% of the total health budget of the 25 Member States from just 1% in 2000 (for 15 Member States).

Recognising the importance of healthcare in society, FP7 sets the challenge for ICT research to support a new era of sustainable and personalised healthcare. Progress in medical and bioinformatics will help scientists to access distributed data sources to analyse and share information quickly and cheaply. This will help in the development of "designer" drugs for targeted sub-populations of patients. Electronic medical records will help doctors to optimise treatments for individual patients based on risk factors, their case history and even their genetic make-up.

Health and ICT at a glance

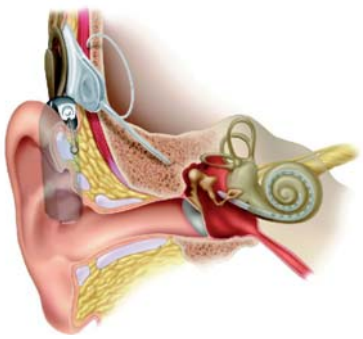
The healthcare sector has long been a leader in innovation, always pushing pioneering techniques and drug discovery. ICT now opens up a whole new world of opportunity that will especially improve value-for-money, personalised service delivery.

ICT also offers excellent opportunities for non-invasive monitoring and imaging systems and point-of-delivery diagnostics. The miniaturisation of ICT hardware now makes it possible to make wireless, implantable medical devices and monitors that can transmit vital statistics and alerts to external devices. This personalised monitoring is especially important in preventative medicine for individuals at risk or suffering from chronic health conditions, including those associated with ageing.

All healthcare related ICT-based R&D will address user needs, personal data security, confidentiality, privacy as well as the reimbursement scheme and legal framework for using new systems. The integration of novel technology in existing healthcare processes and structures, and the interoperability of systems, will also be considered. With a focus on the needs of the growing elderly population, research in this area contributes directly to the development of an inclusive European information society, a priority set out in the i2010 framework.

The ICT PSP Work Programme 2007-2008 is also focusing in part on EUwide implementation of e-Health services to support continuity of care. In particular, it will fund a pilot trial for electronic summaries of a patient's health record and e-prescription technologies and procedures.

The application of ICT in healthcare will ensure that Europeans can enjoy a high quality of life, secure in the knowledge that the personalised treatment they receive is based on thorough research and comes at the best possible price.



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Projects in action

IntelliDrug
Healthy Aims
OPTIVIP
MiViP
WEALTHY
MyHeart
MEDICS
SYMBIOmatics
HKIS

Since the very earliest days of medicine, patients have been notoriously bad at taking their pills. But ICT microtechnology could finally solve the conundrum of patient compliance – delivering the right drug dosage to patients at the right time. The **IntelliDrug** project has developed a false tooth that contains a drug reservoir, valve and timing controls which are programmable via infrared radio-frequency identification (RFID) and GSM telephony. It could be used for any drug, for example in people with hypertension to combat morning increases in blood pressure.

The IntelliDrug tooth is just one example of how micro-technologies are pushing the boundaries of medical innovation. In four years, the 27 partners of the **Healthy Aims** project have pioneered several novel implants. One of the devices trialled so far uses a camera chip, mounted on a pair of glasses, to transmit data to an array of electrodes implanted in the eyeball. It enables some blind people to see a range of colours and recover a certain level of visual stimulation. This device builds on earlier European projects, including **OPTIVIP** and **MiViP**. Other devices include a cochlea implant and a glaucoma sensor that uses a contact lens incorporating a 'strain gauge' to monitor the pressure within the eyeball.

All Healthy Aims devices highlight the importance of ICT for modern implants. Wireless technology, for instance, allows the implants and sensors to receive and transmit data without any wiring. The devices share a technology (based on the 'medical implants communications service', or MICS, standard) that can transmit radio waves from an implant to a receiver worn on the body. The partners have also developed arrays of tiny microelectrodes to stimulate nerves or muscles and the connectors to join them to supporting electronics, along with two prototype implant power sources: a rechargeable battery and a fuel cell powered by the body's own glucose.

Wearable medical devices are also becoming more functional with the development of so-called 'smart fabrics' – textiles that incorporate ICT. The WEALTHY project has already demonstrated prototype garments that contain tiny sensors to collect information about the wearer's respiration, core and surface skin temperature, position (standing or lying down) and movement. The garment also integrates a miniaturised GPRS transmitter.

Building on WEALTHY's success, MyHeart is a large-scale integrated project of 33 partners that is looking to develop intelligent clothing to reduce cardiovascular disease in Europe. MyHeart garments must continuously monitor vital signs, detect trends, make on-the-spot diagnoses and communicate with remote healthcare providers.

Europe's leading role in this field stems partly from the foresight of earlier European projects such as the **MEDICS** consortium. Working to build links between the biomedical and microtechnology industries, the project pushed for industry standards covering biocompatibility, device security, quality and medical device regulations. The MEDICS collaborators also developed the circuitry for the world's first swallowable "camera-in-a-pill", paving the way for wireless capsule endoscopy – a clinical imaging technique now in widespread use.

ICT technology is not just revolutionising treatment on the microscale. The processing power of modern computers has spawned an entire discipline: biomedical informatics. Completed in September 2006, the **SYMBIOmatics** project has highlighted 13 research priorities and areas for innovation in the field. These include the development of clinical decision-making tools and the integration of genetic information into medical diagnostics and prognostics. The expansion and integration of informatics into the clinic could provide an important fillip to the field of genetic medicine, whereby patients receive optimised treatments depending on their genetic make-up.

The **HKIS** project is just one example of how the SYMBIOmatics findings have been implemented. This project developed a system that allows doctors and bioscience professionals to access and analyse oncology data from numerous, previously incompatible, public and private data sources over the internet. Users can run statistical mining or algorithms, which may show why the genes of some patients are more susceptible to cancer and thereby highlight new approaches to treatment and prevention.

More information

IntelliDrug: http://www.intellidrug.org/

Healthy Aims: http://www.healthyaims.org/

HKIS: http://www.hkis-project.com/

SYMBIOmatics: http://www.symbiomatics.org/

MyHeart: http://www.hitech-projects.com/euprojects/myheart/

MEDICS: http://www.medics-network.com/

OPTIVIP: http://www.dice.ucl.ac.be/optivip/

ICT and health and medicine stories on ICT Results: http://cordis.europa.eu/ictresults/ (enter search terms 'e-health', 'biology in ICTs', 'bio-IT interface')


© Hiding Dies

Small chips, but packed with power

Forget about the microchip. We are entering the new age of nanoelectronics, taking the application of ICT to new levels. If Europe is to keep enterprises and public services at the forefront of innovation, then it must also ensure that its ICT fabrication expertise keeps ahead too.

Every consumer knows the consequence of Moore's law: your new computer is out-dated and comparatively 'slow' within months of purchase. ICT is continuously "shrinking", so you can pack more transistors into the standard-sized silicon chip. Indeed, you can fit the same processing power on a single microchip today as filled an entire room less that 50 years ago.

Europe has major strengths in the supply of IT hardware and software components and their integration and deployment into intelligent systems, from portable devices to cars and manufacturing plants. But it has to maintain this position too; the innovative electronics component sector in turn supports the competitiveness of industrial strongholds such as the automotive sector, avionics, industrial automation, consumer electronics, telecoms and medical systems.

In the electronics sector, you can only keep up if you can scale down. So, through tweaking or total transformation, microchip fabrication is continuously improved as manufacturers attempt to fit as much as they can onto their silicon wafers. European research is playing a leading role in the international effort to drive miniaturisation. The EU's R&D strategy fully supports the International Technology Roadmap for Semiconductors (ITRS) and the strategic research agendas drawn up by several European Technology Platforms.

The ICT Work Programme 2007-2008 envisages industry at the centre of a number of projects that will target R&D into new manufacturing technologies, chip design technologies and the integration of different materials and microtechnologies into packaged, microscale systems. The Joint Technology Initiative ENIAC, with an estimated budget of €3 billion will target the next level of miniaturisation required to cross the threshold from micro- to nanoelectronics, as more and more functions are integrated into simple commercial products.

Miniaturisation at a glance

Innovation in manufacturing techniques are allowing chip designers to pack evermore processing power into electronic devices, creating opportunities for exciting new business and consumer applications.

Given the strong industrial application of R&D in this area, support measures are particularly important. Some activities will help SMEs to access prototyping, design expertise and training, and give universities and research institutes opportunities to acquire affordable industrial design tools, and state-of-the-art technologies for prototyping and training.

Although this field of research appears highly technical, and far removed from the gadgetry of the high street, innovation in component design and manufacturing will soon filter into more powerful and functional ICT hardware and accompanying applications. A strong competitive position for the European nanoelectronics sector should enable European industry to lead and anticipate progress in the context of the ITRS roadmap. For the economy, the leadership and innovation displayed by European industry and research organisations will provide an increased number of highly skilled jobs in design and related services.

The EU is embracing the burgeoning field of nanoelectronics. Not only will citizens enjoy evermore-intelligent gadgetry, but also benefit from innovative applications of high economic and socio-economic relevance, for example, in communications, health, environment, transport and security.

Projects in action

Hiding Dies
PROSYD
PICCO
SOUVENIR
PROMENADE
Biofinger

A consortium of European researchers has developed a commercially viable technique to embed active chips in printed circuit boards (PCBs). "Packaged chips, the things that look like black plastic beetles on a circuit board, are an obstacle to further miniaturisation of devices such as mobile phones and PDAs," explains Andreas Ostmann, a researcher at the Technical University of Berlin and coordinator of the **Hiding Dies** research project. "Several years ago we foresaw this problem facing the trend toward smaller, more compact and more reliable devices."

The project, involving commercial partners, such as Philips and Nokia, developed and tested a method to embed chips in PCBs, creating small components that are also relatively cheap to produce. The first products incorporating them are due to go on sale in less than three years. The smallest module produced with the Hiding Dies technology is around 100 micrometers, compared with a minimum of 500 micrometers for current chip packages.

Whatever the manufacturing technique, designing a microchip in the first place is a tricky business and fraught with error. Currently, engineers describe, in minute detail, a microchip's function and production in plain English. But English is not a mathematically precise language, so at each development stage engineers render the English specification list into a mathematically precise function set. Problems of interpretation are rife – and greatly exacerbated when errors in poor language translations also come into play.

Fortunately the standards body, the IEEE, has adopted the property specification language (PSL) as an industry standard for describing microchip properties. And the European **PROSYD** project has set about to create tools to deploy PSL for chip design, fabrication and verification. The project has used these tools to demonstrate PSL's benefits and promoted it as a new industry standard. At the end of the two-year, €7 million project, PROSYD demonstrated a staggering reduction in design errors of up to 100%, at the same time increasing design efficiency by 16 to 22%. Many companies outside the project are now using the PROSYD suite which should lead to impressive gains in chip efficiency and functionality.

Along with progress in electronic design, another project is looking at better designs for photonics circuitry – where light is switched on in optical networks, usually for telecommunications applications. The work of the **PICCO** project has provided evidence that functional photonic circuits can be created using a process called deep UV lithography. This technology, at the very forefront of microchip manufacturing, could lay the foundations for low-cost but high-functionaling micro-optic components. Such advances could give optical component companies a substantial competitive advantage in the telecommunications market.

Even as deep UV lithography transforms microelectronics and microphotonics fabrication, another project has developed a new tool that could herald a new era for nanoscale lithography and yet more miniaturisation of electronics. The **SOUVENIR** project has developed the Soft Ultraviolet Imprint machine which costs a tenth of the current electron beam lithography equipment currently needed for nanoscale fabrication and could be a prototype for the rapid, large-scale manufacture of modern microchips at a sub-50nm scale.

The SOUVENIR technique uses a process called photolithography to etch the circuitry into semiconductors. It is relatively low-cost and low-tech compared to deep UV lithography, which only works properly in a vacuum. It will take a few more years of research to know whether SOUVENIR's work will lead to cheap, mass-produced nano-electronics, but even with this first-generation,

research-level tool the SOUVENIR team has already made significant progress in pushing the boundaries of nanoscale fabrication.

Etching technologies are also used to fabricate microelectromechanical systems (MEMS), miniature machines with moving parts made from silicon. The **PROMENADE** project could make a significant impact on Europe's strength in this field by developing software that helps engineers to design manufacturing sequences for innovative MEMS. Working closely with industrial end-users, the research partners have developed three software modules: a graphical interface for inputting the manufacturing sequence, a simulation package, and a tool that tracks all the parameters at each step in the manufacturing process.

All the data that describes the manufacturing sequence are stored in a database in a standardised format – a breakthrough for the MEMS industry. By making MEMS "recipes" available in a standard format it will be much quicker for manufacturers to transfer the information and to set up fabrication in different units.

Microfluidics use production techniques similar to those used for MEMS manufacturing. An important application of microfluidics is the miniaturisation of entire laboratories onto a single chip. One European project, **Biofinger**, has used micro- and nanotechnology to develop chips that can be used for chemical detection and medical diagnosis. The chips incorporate silicon cantilevers; coated in antibodies that bend and resonate to changes in surface tension and mass when specific molecules bind to the antibodies. Nanocantilevers are so sensitive they can detect a single molecule. The test usually takes between 15 and 20 minutes, considerably less than the hours or days it takes to analyse a blood sample using traditional in-lab methods. Miniaturisation can often mean faster, cheaper and more accurate medical analyses.

More information

Hiding Dies: http://www.hidingdies.net/

PROSYD: http://www.prosyd.org/

PICCO: http://www.intec.rug.ac.be/picco

SOUVENIR: http://www.soft-uv-nanoimprint.com/

PROMENADE: http://ckftp.cavendish-kinetics.com/promenade/

Biofinger: http://www.biofinger.org/

ICT and miniaturisation stories on ICT Results: http://cordis.europa.eu/ictresults/ (enter search terms 'micro-electronics', 'opto-electronics', 'nano-electronics').

Internet access for all

Many remote and rural parts of Europe do not have telephone lines or are too distant from their local exchange to obtain adequate broadband speeds. These areas are effectively excluded from the economic and social benefits stemming from novel online services that rely on high-speed connections. But researchers are finding new ways to get internet access into these "cut-off" communities.

The lightening fast broadband of today seemed inconceivable in the days of dial-up, when text-only versions of web pages were essential for most users. Yet thanks to broadband technology, in half a decade, Europe has seen the internet move from its position as a novel technology for delivering information to an essential part of the mainstream multimedia mix.

In 2006, one-third of households and three-quarters of enterprises in the EU25 had broadband connections. But for some European citizens, high-speed internet access is a pipe dream. Some people live in remote areas without access to a telephone landline. Others are too far from their local telephone exchange, making conventional broadband delivery unfeasible.

The EU's i2010 strategy emphasises the benefits of broadband, stating that they are so important for European innovation that the inability to have access to broadband "is an issue which should be addressed urgently."

The general lack of access within certain communities and sub-populations is known as the "broadband gap". Extending broadband access to geographical groups that are "cut off" from the high-speed infrastructure is especially important in securing their long-term, sustainable development. The availability of broadband services is one critical element in assisting local communities in attracting businesses, in enabling tele-work, providing healthcare, and improving education and government services. It provides a critical link to information.

The EU is tackling this form of "digital divide" on many fronts. Action by the Commission aims to raise awareness of the problem and highlight how Member States can use various EU-level instruments to both liberalise markets and provide state aid where appropriate.

A resolution by the European Parliament on building a European policy on broadband (19 June 2007) takes the view that "the key to closing the broadband gap is innovative technology, that is technology which makes it possible to construct high-capacity broadband connections," and points to the fact that "new technology has allowed disadvantaged regions to leapfrog many phases of development." It also points out that "developing the competitive advantages and solving the serious problems of rural, sparsely populated and inaccessible (island, mountain and other) areas depends on innovative uses of information and communication technologies (ICTs)."

FP7 and CIP are both funding projects to push the technological boundaries and rollout of innovative broadband infrastructures and delivery technologies. New components can bring down the costs of extending broadband networks to sparsely populated regions whilst entirely novel access routes, especially using wireless technology, could allow isolated sites to finally "hook up" to the highspeed digital highway without incurring prohibitive charges.

Broadband and rural development at a glance

As more and more consumer, business and public services go online, several European research projects are finding alternative ways to deliver fast internet access to more businesses and homes. Broadband connectivity is essential for Europe's knowledge society.

Projects in action

FUNFOX
OPERA
IBIS
SATLIFE
Capanina
SEEMP

Optical fibres offer broadband speeds up to ten times faster than traditional copper wires. However, it is not yet economical to mass produce the switching and routing components needed to distribute optical signals to every home.

The **FUNFOX** project has developed two key components. At one end of the optical fibre, the FUNFOX team created a chip integrating a laser and a wavelength monitor. At the other end, they built a one-chip receiver to separate the different wavelengths of light (a process called demultiplexing) and convert them into electrical signals. With the transmitter and receiver each built into a single chip, these two innovations hold the promise of cheap, mass-produced chips for rolling out fast optical telecommunications networks on a big scale.

Another way to solve the problem of the "last mile" – reaching people's premises – is to use the power grid as a broadband delivery infrastructure. Power line communication (PLC) is particularly useful in remote areas and countries where phone lines are in short supply. However, the weak data signals are easily overwhelmed by electrical "noise" on the grid, and can also interfere with nearby radio transmissions. Moreover, PLC signals can only travel a few kilometres before they become too feeble, and they cannot pass through transformers at all.

The **OPERA** consortium is reported to have developed the only PLC technology to have been demonstrated under real conditions. OPERA's advantages in terms of speed, robustness and lack of radio interference, put the technology in an excellent position to become a world standard.

Of course, the wired infrastructure is only part of the global communications network. Satellite communication is equally important. By incorporating onboard digital processing, the **IBIS** project has developed next-generation satellite communications technology which is more versatile and designed for interactive services.

A followon project called **SATLIFE** unites the work of IBIS and the AMERHIS project, funded by the European Space Agency. It is exploiting the results of these projects and demonstrating commercially viable services that use the technology. "Now," says Miriam Catalán, SATLIFE coordinator, "communication can go from sender to satellite and then directly from satellite to recipient. Your delay is halved. Combined with signal regeneration onboard the satellite, which increases the power of the signal received on the ground, this allows us to offer innovative new services at lower cost."

It should be possible, for example, to beam broadband internet access and even real-time applications like voiceover IP via satellite through the satellite network. This is especially beneficial to remote and developing communities that are not served by the terrestrial communications infrastructure.

Some communities may also get broadband access via balloons. 'Stratospheric broadband' use so-called high altitude platforms (HAPs) floating 20km above ground to deliver data wirelessly up to 200 times faster than an ordinary wired broadband. The **Capanina** project has estimated the cost of a HAP-related device to be one-tenth the cost of a satellite. HAPs could offer cheaper solutions for medium-density areas, filling the gap between cables/fibre for high-density cities and satellite for sparsely populated areas.

Innovation does not rest purely on ever-faster data transfer, however. Many European projects are looking at how to exploit broadband access to facilitate other avenues of innovation.

SEEMP – Single European Employment Marketplace – is one such project. The partners are developing an infrastructure that allows any employment agency in Europe, public or private, to exchange information on vacancies and candidates with any other agency. It aims to open up the European jobs market and allow employers to access the best candidates from across the whole of Europe. A greater flow of personnel will also stimulate innovation through the exchange of new ideas and wider networking. The first SEEMP prototype, connecting public employment agencies in Lombardia in Italy and Wallonia in Belgium with EURES, has just been completed. The final system should be rolled out late in 2008.

More information

FUNFOX: http://www.iota.u-psud.fr/~funfox/

OPERA: http://www.ist-opera.org/

SATLIFE: http://www.satlife.org/

Capanina: http://www.capanina.org/

SEEMP: http://www.seemp.org/

ICT and broadband stories on ICT Results: http://cordis.europa.eu/ictresults/ (enter search terms 'broadband technologies', 'access for all', 'broadband (and regional development), 'telecommunications', 'wireless and mobile technologies').


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Intelligence everywhere

It is hard to imagine why you might need ICT installed into a fridge or sofa, but now that microtechnology is so cheap it is finding its way into all manner of everyday products. Pervasive computing has many advantages, and EU researchers are working to overcome the remaining hurdles for ambient and embedded technology.

The news media frequently covers the topics of pervasive computing and "smart homes", but it loves to throw in the big white elephant of embedded systems: the "connected fridge". Nevertheless, as ICT finds itself increasingly incorporated into everyday objects, you start to appreciate society could benefit from many exciting opportunities that embedded technology offers.

People with chronic health problems, for example, could have monitors woven into their clothes. These could keep an eye on their vital statistics and transmit alerts – perhaps a text to the individual's mobile phone if blood sugar or pressure levels become dangerous. In the automotive industry, embedded systems are already making vehicles more efficient and safer. They are also providing communication and location technologies for emergency services.

The digitisation and networking of home appliances and entertainment media, as well as the convergence of PCs and communications, is already giving rise to a new breed of intelligent consumer electronic devices. For example, digital TVs will soon allow you to access all sorts of content, such as digital photos or stored movies, as well as the internet or games. Linking up embedded systems also provides scope for building "collective intelligence" that, in turn, can achieve new levels of comfort, safety and productivity in all areas, from the individual to industrial environments.

This European ICT sector invests around €15-20 billion per year with nearly 50% of the 100 biggest European companies investing in embedded systems research. And Europe intends to sustain its leadership in this field. One of the most important initiatives is the ARTEMIS Joint Technology Initiative for Embedded Systems, launched in early 2007.

Embedded and ambient technology at a glance

Embedded systems should help Europe achieve new levels of comfort, safety and productivity in all areas, from the individual to industrial environments. European research is revelling in this innovative, smart society by developing cheap, interoperable ICT systems.

ARTEMIS is expected to have a budget of around €3 billion over seven years, of which more than 50% should come from industry.

FP7 is also geared to meet the challenges of embedded systems and pervasive networking. The overall goal of ICT Challenge 1 – focusing on pervasive and trusted network and service infrastructures – is to enable the emergence of network and service technologies that open up new application scenarios and innovative business models, thus creating novel business opportunities and growth. Significant R&D and industrial agreement on open architectures and standards are still required to ensure interoperability between different embedded systems.

The Intelligent Car flagship initiative of i2010 particularly highlights the future of embedded systems. The Commission is currently negotiating with car manufacturers for a pan-European in-vehicle emergency call system (eCall) to be incorporated as a standard option in all new cars from 2010. The initiative will also further promote the take-up of other life-saving technologies and investigate how ICT can help make cars greener and smarter.

Another flagship initiative, the Ambient Assisted Living (AAL) initiative holds wide scope for the development of innovative embedded solutions that could help the ageing population to live more independently. The initiative could push for more intelligent medical implants, remote patient monitoring or systems for controlling household appliances using mobile phones, for example.

With so much R&D aimed at developing functional, interoperable and cheap embedded ICT, there is little doubt that Europe will quickly reap the rewards of these "smart" innovations.

Projects in action

TEAHA
MAGNET
MAGNET Beyond
ASAP
CORTEX

Fancy calling your home and telling it to start the laundry, fill the bath or turn down the heating? Smart homes have long been talked about, but never fully realised. To date, appliance manufacturers, telecommunications firms, utility companies, software designers and systems installers have often taken very different paths towards deploying new technologies in the home.

The **TEAHA** project has brought companies from all these sectors together. The outcome could be the first open smart-home platform to allow domestic devices – using any technology and made by any manufacturer – to interoperate seamlessly with one another. The TEAHA system achieves this interoperability using a middleware platform to mediate between different appliances and communication systems. TEAHA has also researched new ways for devices to communicate with one another, for example by using radio-frequency signals or domestic electrical wiring circuits.

The devices in a smart home could also become part of a personal area network (PAN), the collection of gadgets and devices connected to an individual. The **MAGNET** project developed software and hardware to overcome the challenges of device discovery and connectivity in PANs. It also produced a low-power consumption and low-complexity, radio-based chip for low-data rate applications (e.g. from smoke alarms), and another solution for applications with higher bandwidth needs.

A follow-on project, **MAGNET Beyond**, seeks to make the PAN hardware and software an easy-to-deploy commercial reality. The first applications will be for doctors in Denmark to monitor remotely homecare patients suffering from diabetes.

Most of the hardware already exists to add ICT functionality to anything from clothing to cars. And at last the software is catching up. The **ASAP** project has solved the problem of creating and adapting software to run efficiently on the tiny computing systems embedded in everyday objects and environments. The result is a groundbreaking open source toolkit that uses Constraint Logic Programming (CLP) languages. The decision to use CLP for pervasive computing not only represents a clean break from the norm, but a major innovation that will smooth the rollout of more complex software for the tiny, ubiquitous computers of the future.

Until ASAP, the use of CLP languages, which simplify programming and make software more portable across different platforms, had not been considered feasible for pervasive systems because they produce generally less efficient and more resource-hungry code. But the ASAP toolkit employs an easy-to-use language called Ciao that is optimised to reduce resource consumption. The project partners believe their CiaoPP toolkit could help devices become embedded in everyday objects on a massive scale within five years.

Embedded ICT is also driving progress in the development of so-called sentient objects – self-aware machines that will reliably perform automated tasks without any human intervention. Firstly though, developers need to overcome the shortcomings of current ICT systems which are still largely based on sequential programming models. “If we are to construct highly interactive things like mobile robots, wearable devices that can react intelligently to their environment, augmented-reality systems, etc., we need to know how to programme these applications,” says Paulo Verissimo, coordinator of the **CORTEX** project.

When the project ended in September 2004, the participants had produced a suitable open, scalable system architecture for sentient objects and also prototyped the middleware needed to support the new programming model. CORTEX demonstrated its work in a simulation of co-operating cars, using software developed by the project to emulate real environments for testing safety-critical or safety-related applications. In the test, the vehicles could communicate with one another via wireless links and react to movements to avoid accidents. The cars could cross a junction in a continuous stream without collision usually by slight adjustments of their speed at the approach to the crossroads.

More information

TEAHA: http://www.teaha.org/

CORTEXT: http://cortex.di.fc.ul.pt/

MAGNET: http://www.telecom.ece.ntua.gr/magnet/

MAGNET Beyond: http://www.magnet.aau.dk/

ASAP: http://clip.dia.fi.upm.es/Projects/ASAP/

ICT and embedded and ambient technology on ICT Results: http://cordis.europa.eu/ictresults/ (enter search terms 'embedded systems')

What's inside?

Content for this publication was provided by the *ICT Results* editorial service, working to showcase breakthrough ICT research in Europe. It is part of a series of domain surveys drawn together from articles featuring EU-funded ICT research.

ICT Results

http://cordis.europa.eu/ictresults

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FP7 ICT Work Programme
http://cordis.europa.eu/fp7/ict/

Information Society Policy Link initiative:
http://ec.europa.eu/information_society/activities/policy_link

Europe's Information Society: Thematic Portal
http://ec.europa.eu/ecom

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