

EU Innovation and Research Policies and Future Trends in Microsystems

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The socio-economic growth of industrialised countries is largely explained by the level of Information and Communication Technologies (ICT) investment, research and use as well as the competitiveness of the industries in this domain. Microsystems and Smart Systems Technologies are one of the most important drivers of ICT, a sector that accounts for 40% of the productivity growth in the European Union and where Europe holds a good competitive position.

The European Commission has traditionally recognised the importance of this field and supported European R&D activities in the area of Microsystems since 1994, throughout several Framework Programmes. More recently, the creation of the European Technology Platforms (ETPs), and specifically the ETPs on Smart Systems Integration (EPoSS), Nanoelectronics (ENIAC) and Embedded Systems (ARTEMIS), has also contributed to bringing together key industrial players, SMEs, public authorities and the research community to define R&D priorities in this field. Nowadays, in the Seventh Framework Programme (2007-2013), Microsystems continues being a priority objective of R&D activities in the ICT Programme. In 2007, the first call on "Micro/nanosystems" was launched within the FP7, with a focus on heterogeneous integration technologies and systems. Similarly, the next ICT work programme 2009-2010, currently under preparation, will cover this domain with an emphasis on key issues for this field such as energy efficiency, intelligence integration and smart heterogeneous integrated systems for a wide range of applications.

Innovation and research policies in the European Union

The different economic performances of industrialised countries are largely due to the level of competitiveness of the Information and Communication Technologies (ICT) industries and the level of ICT invest-

ment, research and use. In addition, in Europe, the field of ICT makes a major contribution to growth and employment, accounting for around 25% of European Union (EU) Gross Domestic Product (GDP).

This contribution of research and innovation to the generation of economic growth and employment has been recognised by the European Union since the earliest Treaties and has also been emphasised recently by the launch of the Lisbon Strategy and the i2010 initiative. In establishing the partnership for growth and jobs as a new start for the Lisbon strategy, knowledge and innovation were identified as key pillars for sustainable socio-economic growth in the European Union. In particular, given the crucial contribution of the ICT sector to growth and employment in Europe, innovation and investment in strategic ICT research, in areas where Europe has recognised strengths or in emerging, targeted fields, are considered essential to support Europe's international competitiveness and sustainable socio-economic growth.

The i2010 initiative, adopted by the European Commission in June 2005, represents a step forward to reaching the Barcelona target of 3% GDP investment by 2010 and entails an increase of 80% in EU-wide investment in research on ICT by 2010. In addition, the European Commission has launched two major programmes to reinforce Europe's research position: the Seventh Framework Programme (FP7) and the Competitiveness and Innovation Programme (CIP), along with the Education and Training Programmes, and Structural and Cohesion Funds for regional convergence and competitiveness.

The European Union Framework Programmes (FPs), implemented since 1984 and covering a period of 4 years, are the main financial tools through which the European Union supports research and development activities covering almost all scientific

disciplines. The on-going Framework Programme, the Seventh Framework Programme (FP7), has been designed to build on the achievements of its predecessor but also includes important new elements, such as the significant increase in its budget to 50,521 million euros and its duration, which will be seven years (2007-2013).

Microsystems and Smart Systems Technologies in Europe's Research and Innovation Initiatives

Microsystems and Smart Systems Technologies are one of the most important drivers of ICT, playing an important role in modern knowledge-based economies since they are spread in all sectors of the economy through an endless range of applications. In addition, Microsystems and related advanced technologies are one of the areas where Europe holds a good competitive position, since the European industry is a world leader in the field. The relevance of Microsystems and Smart Systems Technologies comes not only from the importance of this market but also from the high added value that the smart heterogeneous systems provide to the applications and systems into which they are inserted. Therefore, Microsystems has been a priority objective of the EU main research tools, the Framework Programmes, since 1994.

During the FP4 (1994-1998) the European Commission funded the first R&D projects in the area of Microsystems with an emphasis on Micro-Electro-Mechanical Systems (MEMS). With the FP5 (1998-2002) the interest moved from MEMS towards Micro and Nanosystems (MNS) and Micro and Nanotechnologies (MNT), where the focus was on the industrial applications of MEMS and Micro-Opto-Electro-Mechanical Systems (MOEMS). During the FP6 (2002-2006) the attention was focused on the industrial applications of the systems covering all steps needed to form systems out of components, systems that are able to capture information from the environment

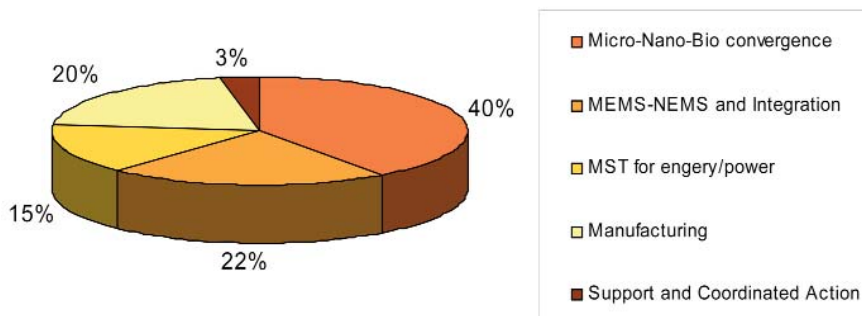


Figure 1: Distribution of FP7 "Microsystems" budget by areas in ICT Call 2 Objective 3.6 (Total budget: 83 M€)

through sensors, to process it electronically, to communicate it and to "close to loop" by taking the appropriate action. Now, in FP7, the focus is on Smart Integrated Systems, systems combining sensing, processing and actuating, systems which are increasingly complex and involve different disciplines and integrate different technologies, making the field of Microsystems technologies expand into "Smart Integrated Systems".

Along with the Framework Programmes, other European initiatives such as the European Technology Platforms (ETPs) have also emerged in the last few years to help define R&D priorities in a number of strategic areas for Europe, including Microsystems. The European Technology Platforms, an industry driven forum conceived to support the European Research and Innovation Area, provide a framework for stakeholders, industrial players, SMEs, public authorities and the research community to define and implement their Strategic Research Agendas (SRAs): medium to long-term strategic technological objectives, timeframes and action plans for challenging areas. In so doing, the European Technology Platforms focus on future markets for key technologies and ultimately will contribute to helping Europe maintain its leadership in these industrially relevant areas.

In the field of Information and Communication Technologies, there are currently 9 ETPs active, the ones on Smart Systems Integration (EPoSS), Nanoelectronics (ENIAC) and Embedded Systems (ARTEMIS) being those more linked to Microsystems. The launch of the ETP EPoSS has been

particularly relevant to the field of Smart Systems Integration, since EPoSS can play a key role in helping Europe keep its lead role in this field by, among others, ensuring an adequate concentration of research funding in this field or the identification of strategic research priorities in the Strategic Research Agendas.

Similarly, in this area the European Commission has been funding R&D projects and support measures to help European research and industry gain access to Microsystems technologies and Microelectronics for more than ten years under the EURO-PRACTICE label. In particular, EURO-PRACTICE has specially contributed to helping European SMEs gain access to technologies that they could not easily implement in-house. The programme has not only covered manufacturing/foundry services but also feasibility, design and consulting services.

In addition, in recent years training and education have been of growing importance. Similarly, the integration of organisations from the New Member States as service suppliers, but also as service users, has been a challenge in the last few years and will still need further attention during FP7, throughout which the funding to this area will continue via the Nanoelectronics and Micro and Nanosystems initiatives under the ICT Programme.

Microsystems and Smart Systems Technologies in the Seventh Framework Programme

The Seventh Framework Programme (2007-2013) has been designed to build on the achievements of FP6 to-

wards the creation of the European Research Area (ERA) and carry it further towards the development of the knowledge economy and society in Europe. The broad objectives of FP7 have been grouped into four categories: Cooperation, Ideas, People and Capacities, the Cooperation Specific Programme, with a budget allocation of 32,413 million euros being the one which supports all types of research activities and aims to consolidate or gain leadership in key scientific and technological areas.

The ten distinct themes covered by the Cooperation Programme reflect the most important fields of knowledge and technology where research excellence is particularly relevant, with Information and Communication Technologies being one of these priorities. Similarly, in FP7, Microsystems and Smart Systems Technologies continue being a priority objective of R&D activities in the ICT Programme.

In 2007, the first call on "Micro/nanosystems" was launched within the FP7, with a focus on heterogeneous integration technologies and systems. More precisely, the emphasis was on heterogeneous integration of technologies (e.g. electronics, mechanics, biotechnology, fluidic, magnetic) for the implementation of multiple functionalities (sensing, processing, communication, energy, memory, actuating), which fully aligns with the current trend towards the increase in the value of components and Microsystems through the integration of added functionalities (Smart Systems Integration). Six areas were specifically targeted in this call:

- Next-generation smart systems,
- Micro/nano/biotechnologies convergence,
- Integration of smart materials,
- From smart systems to viable products,
- Smart systems for communication and data management,
- Support actions.

The response to this call on Micro and nanosystems showed the increasing importance and interest of the European research community in this field, highlighted by the over-subscription of this objective, which

has attracted a total number of 190 proposals, involving more than 1,680 participants and requesting funding of approximately 698 million euros.

Overall, Micro and nanosystems can be considered certainly well covered after this call, since 26 new R&D projects have been funded in the field, with an EC contribution of 83 million euros. These R&D projects are bringing together researchers, industries and end users from 228 different organisations coming from the Member States, the Associated Countries and other countries outside the EU, building a large research community in Micro and nanosystems, thereby contributing to the reinforcement of the ERA.

In terms of contents of the FP7 project portfolio in the domain of Microsystems and Smart Systems Technologies, the new R&D projects concentrate on Micro-Nano-Bio convergence (2 IPs and 7 STREPs and a total budget of 33,6M€), MEMS-NEMS and their integration (6 STREPs and a total funding of 18M€), Microsystems technologies for energy and data storage (4 STREPs and 12,3M€ of funding), and manufacturing (1 IP and 3 STREPs and a total budget of 16,8M€). Support and coordination actions are also duly covered following this call (3 CSAs and a budget allocation of 2,25M€).

In the field of Micro-Nano-Bio convergence, two large IPs have been funded, one covering the development of ultra low-cost laboratories on chip, and the other one a health-care application based on micro-robots and integrated Microsystems technologies for endoluminal surgery. Moreover, the portfolio in this domain has been enriched with 7 more STREPs. Examples of some of the areas covered by these projects are: monolithically integrated interferometric biochips for early detection of human diseases, nano-actuators and nano-sensors for medical applications, imaging sensors for minimally invasive surgery or a system for the induction of sensation and treatment of phantom limb pain.

The area of manufacturing is also largely covered by one IP on high density integration of electronic cir-

cuits and 3 more STREPs addressing cost-effective multifunctional RF-system integration, thin interconnected package stacks, and a smart inspection system for high-speed testing of MEMS and MOEMS.

Moreover, another cluster of projects that has been funded following this call is in the domain of MEMS-NEMS and integration. This group of projects covers M/NEMS technologies for a variety of applications, ranging from integrated circuit systems for sensing and power management applications to MEMS for security and communications or for smart wireless applications.

As for the support actions, the focus is on Microsystems and smart systems integration training, the coordination and implementation of a European strategy on Smart Systems Integration in line with the SRA elaborated by EPoS, and intelligent textile materials.

Finally, particularly remarkable is the importance acquired by the area of Microsystems technologies for energy and power. 2 new innovative STREP projects have been funded in this field, addressing power optimisation and energy storage. The topics targeted by these projects are the development of environmentally friendly thin-film batteries and efficient smart systems with enhanced energy storage. Similarly, the area of data storage is also covered by two projects addressing magnetic storage technologies and super-resolution photonics for advanced storage systems.

The expected impact of the projects funded is defined in the following terms:

- Substantial improvement in various aspects of smart systems integration: higher product quality and reliability, increased miniaturisation, integration and functionality, lower costs, reduced power consumption, higher speed requirements and/or shorter time to market.
- Transformation of industrial production by adding intelligence to process control and the manufacturing shop floor, and by improving logistics and distribution, thereby increasing productivity.

- Increased market share for European companies across different industrial sectors by delivering systems with new functional capabilities and improved quality within a competitive timeframe.

Finally, another remarkable result of the first FP7 call for proposals in the domain of Micro and nanosystems is the increasing presence of SMEs. The final figure of SMEs which participate in the new projects funded following this call comes to 21.5%, of a total number of 228 participants. Nevertheless, the presence of research institutions and centres is still predominant, ahead of other types of participants.

Future trends in Microsystems and Smart Systems Technologies

At present, the European industry holds a good competitive position in the area Microsystems and Smart Systems Technologies. However, there is strong international competition which calls for a rapid product change, higher quality, lower cost and shorter time to market. Consequently, Europe has a number of challenges to face in order to maintain its leading position in this domain. Innovation and investment in strategic research priorities are crucial to support Europe's international competitiveness and growth in this area.

Micro and nanotechnologies have kept the interest and relevance achieved within previous Framework Programmes, and R&D activities in this field have been broadly covered also within FP7. The new projects in this domain also ensure a good coverage of the targeted objectives in terms of heterogeneous integration technologies and systems. The R&D priorities for the coming years will be defined by the next ICT work programme 2009-2010, currently under preparation, which will coherently complement the existing project portfolio in the area with an emphasis on increasingly relevant topics for this field such as energy efficiency, intelligence integration, and smart heterogeneous integrated systems for a wide range of applications such as bio-medical, telecommunication or environmental applications. Similarly, some specific fields, such as the integration of Microsystems on smart

fabrics and interactive textiles, or networked sensors integrated in physically limited areas (BAN), might be addressed in future calls.

Furthermore, there are other important challenges for the European R&D initiatives to be faced, such as the transformation of research leadership and technological progress into innovation applications and services and socio-economic growth, or the increase of the participation of industry and SMEs in our R&D programmes. The Seventh Framework Programme has already introduced several new elements which aim to address these issues: significant simplification of its operation; focus on developing research that meets the needs of European industry, through the work of Technology Platforms (ETPs) and the new Joint Technology Initiatives (JTIs); emphasis on research themes rather than on "instruments"; integration of interna-

tional cooperation in all four programmes; a risk-sharing finance facility aimed at fostering private investment in research; the establishment of a European Research Council (ERC) or the development of Regions of Knowledge. The ultimate objective is to contribute to the re-launch of the Lisbon strategy and to support Europe's international competitiveness and sustainable socio-economic growth.

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