European Commission

This fiche is part of the wider roadmap for cross-cutting KETs activities

'Cross-cutting KETs' activities bring together and integrate different KETs and reflect the interdisciplinary nature of technological development. They have the potential to lead to unforeseen advances and new markets, and are important contributors to new technological components or products.

The complete roadmap for cross-cutting KETs activities can be downloaded from:

http://ec.europa.eu/growth/industry/key-enabling-technologies/eu-actions/ro-ckets

Potential areas of industrial interest relevant for cross-cutting KETs in the Electronics and Communication Systems domain

This innovation field is part of the wider roadmap for cross-cutting KETs activities developed within the framework of the RO-cKETs study. The roadmap for cross-cutting KETs activities identifies the potential innovation fields of industrial interest relevant for cross-cutting KETs in a broad range of industrial sectors relevant for the European economy.

The roadmap has been developed starting from actual market needs and industrial challenges in a broad range of industrial sectors relevant for the European economy. The roadmapping activity has focused on exploring potential innovation areas in terms of products, processes or services with respect to which the cross-fertilization between KETs can provide an added value, taking into account the main market drivers for each of those innovation areas as well as the societal and economic context in which they locate.

Taking the demand side as a starting point, cross-cutting KETs activities will in general include activities closer to market and applications. The study focused on identifying potential innovation areas of industrial interest implying Technology Readiness Levels of between 4 and 8.

E&C.2.2: Functionalized cost-effective components ("More than Moore")

Scope:

To develop components and circuits going beyond Complementary Metal-Oxide Semiconductor (CMOS) technologies ("more than Moore") to deliver powerful low cost and/or functionalized computing, sensing and actuation solutions, building on the functionalization of the semi-conductor substrate to enrich the non-digital capabilities of the circuits, manage their growing complexity, enable alternative computer architectures (e.g. self-organizing, reconfigurable, defect- and fault tolerant architectures) or high performance solutions for radiofrequency, sensing and control/actuation microsystems, making all these potentially integratable/coupleable with Complementary Metal-Oxide Semiconductor (CMOS) ("system on chip").

Demand-side requirements (stemming from Societal Challenges) addressed:

- "Innovative and reflective societies" and a competitive European economy need breakthrough innovations, smart capabilities or high performance, a large part of which will be made possible by improved or even radically new electronics components and circuits
- Energy and material resources efficiency are demanding much from electronic components, be it direct energy consumption reduction, advanced power management, low use of critical materials, recyclability, miniaturization, etc.
- Large areas monitoring – as for agriculture, forestry, marine resources, water resources, pollution monitoring, homeland security, etc. – require "smartification" of the environment, e.g. with high autonomy ubiquitous low cost sensing and communication capabilities, serviced by new components, circuits and architectures
- High value systems for energy, transport, health care as well as some industrial, space or military applications need components and circuits for highly demanding applications, severe vibration or temperature environments, high computing power, specific reliabilities, real time operations, miniaturization, upgrade/retrofit,etc.
- Electronic components being a basic bricks for all high added-value systems, maintaining an electronics industry in Europe is a critical matter of strategic non-dependence

Demand-side requirements (stemming from market needs) addressed:

- Electronics industry is a highly competitive market integrated into global value chains, with short cycles and requiring large investments. Keeping caught-up with Moore's law (computing power doubles every two years) as well as with new trends (non-computing capabilities grouped under the "More-than-Moore" concept) is a survival issue for the European electronics industry facing huge global competition
- With electronic and telecommunication systems getting more and more complex, developing circuits and components dedicated to a specific application is a key for competitiveness of entire industries. Industrial eco-systems in consumer or professional electronics require strong interactions with the components and circuits link
- Setting up the "Internet of Things", "Cloud computing" or "Big data" services are major requirements from many industries and services in Europe. It requires developments in components as well as from upper technical layers
- Cost is a key and all components design and production has to integrate competitive production aspects from the earliest phase

Specific technical/industrial challenges (mainly resulting from gaps in technological capacities):

- Development of bottom-up nano-electronics beyond Complementary Metal-Oxide Semiconductor (CMOS)
- Development of alternative computer architectures, as self-organizing and reconfigurable or defect- and fault-tolerant architectures, and related hardware technologies
- Combination of functional substrate materials to improve components' functionalities
- Application of novel known and unknown functional materials for better products (e.g. biobased plastics, graphene)
- Find deployments and applications of advanced materials
- Recycling by design (include life cycle of products and materials into "product planning")

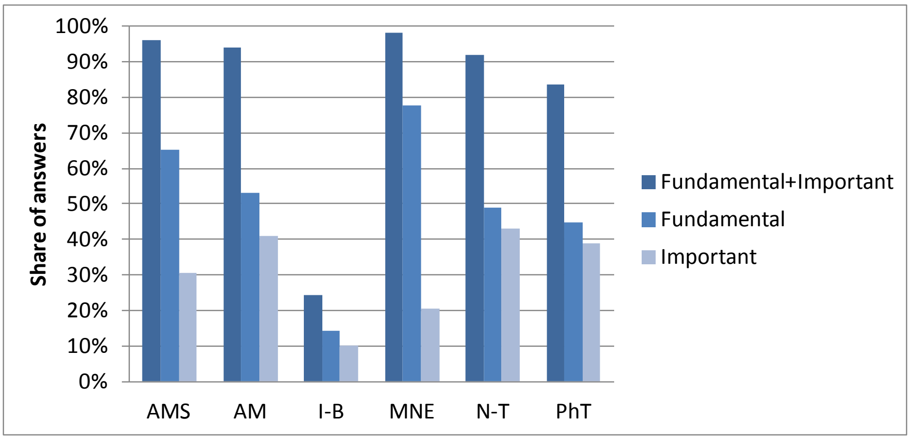
- Further miniaturization of electronics
- Integration/coupling of novel “More than Moore” designs to Complementary Metal-Oxide Semiconductor (CMOS) (system on a chip), packaging and organic electronics (less powerful but lower cost)
- Development of autonomous computing: adaptive, self-configuring, optimizing and repairing systems

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of advanced components and circuits going beyond Complementary Metal-Oxide Semiconductor (CMOS) technologies (“more than Moore”), building on the functionalization of the semi-conductor substrate, alternative computer architectures, the combination of functional substrate materials, miniaturization, packaging and organic electronics, renewable materials and recycling by design approaches.

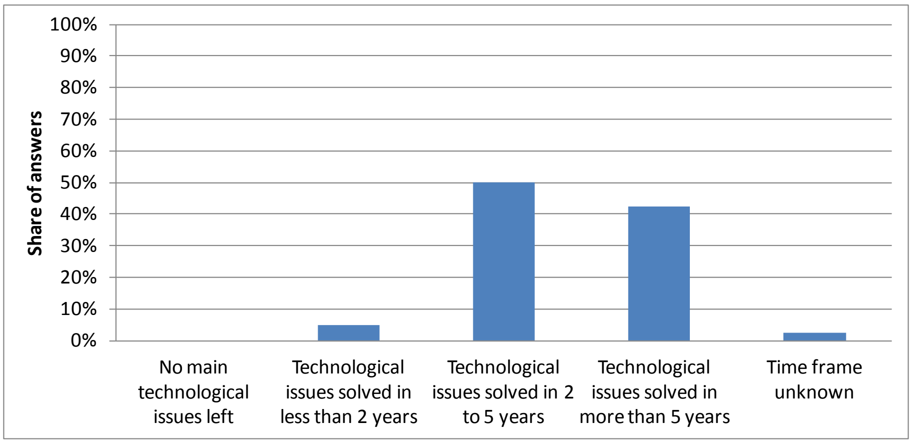
To this aim, the combination of KETs experts’ opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong interaction of KETs with respect to this Innovation Field, with either fundamental or important contribution mainly by the following KETs:

- Micro- and Nano-Electronics (MNE)
- Advanced Manufacturing Systems (AMS)
- Advanced Materials (AM)
- Nanotechnologies (N-T)
- Photonics (PhT)



Timing for implementation:

According to the majority of KETs experts’ opinions (whose result is depicted in the below bar chart), desk research, and in line with the KETs-related patenting activity in this field, it is considered that the main technological issues holding back the achievement of cross-cutting KETs based products related to this Innovation Field could be solved in a time frame of 2 to 5 years, yet significant consensus by experts indicates also longer periods being necessary:



Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the short to medium term should be taken into consideration within this framework.

Additional information according to results of assessment:

- ***Impact assessment:***
  - In the highly competitive environment of the electronic components industry, developing high added-value "more than Moore" products and their advanced production lines at the cross-roads between different KETs is mandatory for guaranteeing that an electronics industry remains viable in Europe, with impacts on European economic and strategic non-dependence and security, but also on European capability to develop and produce products and systems with advanced, innovative and ground breaking capabilities.
  - Beyond conventional digital semiconductor technologies and applications, "more-than-Moore" integrated components and circuits offer the opportunity to convert non-digital as well as non-electronic information – such as mechanical, thermal, acoustic, chemical, optical and biomedical functions – to digital data and vice-versa. This, eventually converged and integrated with advanced digital electronics, allows them to deliver high value functionalities and support breakthrough innovation in wireless communication, power grids, lighting, biomedicine, energy scavenging, imaging, micro-nano sensing, micro-nano actuation, etc. This innovation field is a basic component of many other fields highlighted in the present report.
  - In 2012, just the MEMS-NEMS (Micro and Nano-Electro Mechanical Systems) market reached about 9 billion Euro, with a regular 10-15% annual growth. Up to 56 production fabs are dedicated to Micro-Electro Mechanical Systems (MEMS) in the EMEA (Europe, Middle-East and Africa) area, the two biggest global players – ST Microelectronics and Robert Bosch GmbH – are European, and even though there is a fierce competition in particular from Asian countries, these "more than Moore" components represent a major volume of activity and jobs in Europe, with a large growth potential (Source: Yole 2012 and 2013).
  - Many of the technologies in this field have already been studied and developed by the defence industry for applications in both defence and civilian areas, for example in aerospace. However, a stronger development can be expected in the near future coming also from the potential dual use applications deriving from the know-how developed to be transferred into civilian markets.
- ***Results of patents scenario analysis:***
  - Many different KET related technologies apply to this innovation field, but too few of them highlight the final application or target functionalities, so that the ROcKETs study patent analysis approach is not adapted to delivering results making sense in this field.