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.2.5: Circuits and systems for severe operational conditions

Scope:

To develop dedicated circuits and systems for severe environmental conditions of operation, as much as possible from adaptation of standard high performance electronic, electric and eletro-mechanical (EEE) components to extreme operational conditions (extreme temperatures, out of atmosphere radiations, space launch acceleration and vibrations, nuclear environment, etc).

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, qualification and supply chain certification for radiation hardened components for mixed analogue, digital and RF applications, active or passive
- Development of robust, low and very low noise, linear and low power RF components and devices
- Qualification of an European source for space qualified high performance digital processing capabilities
- Qualification of European sources for high pin count hermetic and non-hermetic electronics packaging
- Development of high voltage / power components capable for high constraints applications
- Enable use of standard commercial off-the-shelf (COTS) components even into most demanding systems

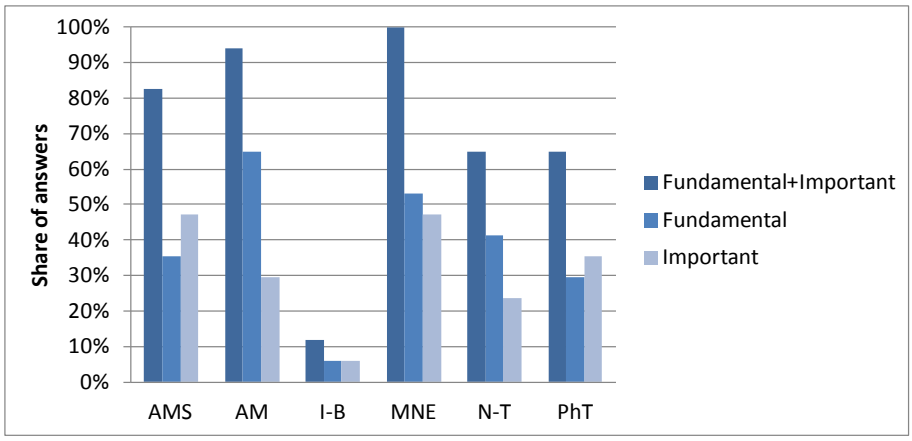
Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of more advanced dedicated circuits and systems for severe environmental conditions of operation, like radiation

hardened components for mixed analogue, digital and active or passive radio-frequency (RF) applications, linear and low power radio-frequency (RF) components and devices, high voltage/power components, etc.

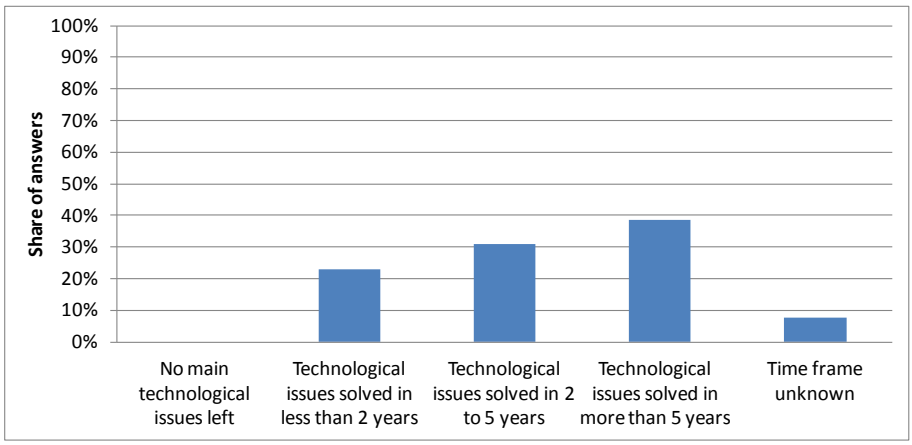
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong 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 Materials (AM)
- Advanced Manufacturing Systems (AMS)
- 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 more than 5 years, yet significant consensus by experts indicates also shorter periods being necessary:

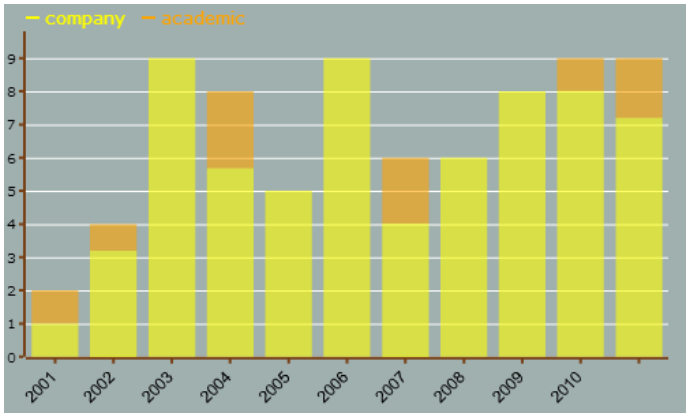


Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field and on the specific environment constraints to be faced as well as considering the rather longer lead times for these technologies requiring reliability demonstrations, the provision of support in the short to medium term should be taken into consideration within this framework.

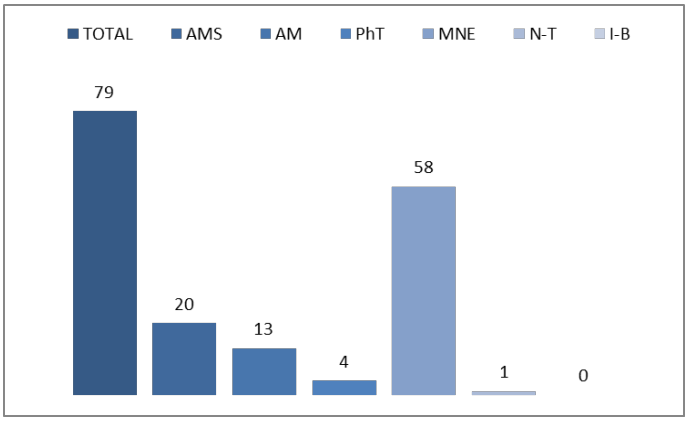
Additional information according to results of assessment:

- ***Impact assessment:***
  - Usual electronics are designed for operating under ordinary conditions of temperature, pressure, vibration, dust, ionizing radiations, humidity, etc. Circuits and systems for operations in harsh environments – including space, underground, underwater, nuclear, deserts, etc. – have to face fiercer operational conditions. Meanwhile, these operations in harsh environments often allow less fault-tolerance, so that requirements on all conditions reliability are higher than for usual components. Circuits and systems especially developed to face severe operational conditions while delivering high levels of performance are therefore mandatory for many applications in scientific research, offshore or underground resource exploration and exploitation, rescue missions, space and/or military activities, dismantling, decommissioning and decontamination of nuclear or otherwise polluted facilities, and eventually some industrial or energetic routine operations.
  - Among these applications, EEE (Electronic, Electrical and Electro-mechanical) components are especially crucial for space activities. With public budget crunches and commercial space reaching the industrial and standardized age, costly development of highly specific and costly fault-proof components and systems is becoming a significant issue. Attempts to use more standard, even directly off-the-shelf, radiation hardened components is a steady trend. Facing same constraints, military or scientific applications will be more and more looking to the same direction.
  - Meanwhile, costs in the electronics sector make it difficult to maintain production capabilities for low volumes of very specific components. The sector is facing concentration phenomena, but Europe has to make sure that it remains non-dependent for these critical components and hardened electronics based on advanced manufactured multi-KET components is a way of guaranteeing such capability.

- ***Results of patents scenario analysis:***
  - 79 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Increasing trend curve (number of patents per year)
  - Highest share of industrial applicants with intermittent relevant patenting activity by academic applicants, most probably standing for new technologies having been patented in the corresponding periods:



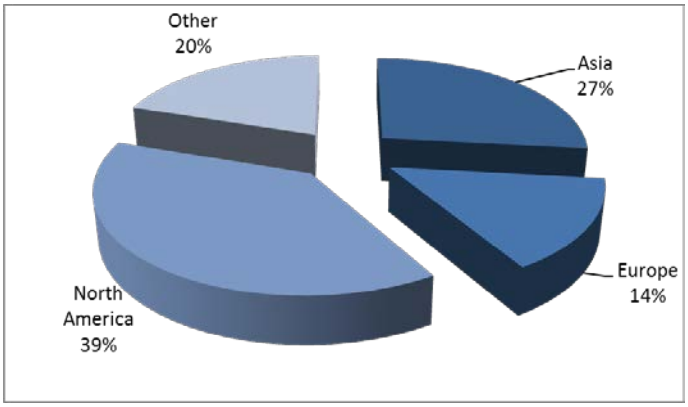
  - Patents by KET(s):



- Patents by KET(s) and relevant combinations of KETs:

KET(s)	*Number of patents*
AM	13
AM / MNE	10
AMS	20
AMS / AM	2
AMS / MNE	5
AMS / MNE / PhT	1
AMS / PhT	1
MNE	58
MNE / N-T	1
MNE / PhT	3
N-T	1
PhT	4

- Patent distribution by (Applicant) organization geographical zone:
- Patent application is very little concentrated, with the biggest applicants (Honeywell and Murata) having only 6 patents each in the period



- Patent distribution by geographical zone of priority protection: