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.4.2: Advanced broadband wireless communication

Scope:

To develop radio-frequency technologies for seamless, high-performance (broadband), reliable, interoperable, efficient and secure wireless communication, including cognitive radio and new radio technologies to make better use of the limited radio spectrum and advanced wireless networks with increased bandwidth and energy efficiency and multiple communication chips in single platforms such as radio-frequency micro electro-mechanical systems (RF-MEMS) or Antennas and radio-frequency (RF) parts for next generation wireless networks.

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

- Inclusive society is also about closing the digital divide (according to the Digital Agenda for Europe (DAE), 78% of EU citizens use the internet at least once a week, 20% never used the internet, and 62% of the EU has 30Mbps broadband, but only 18% of rural areas). Skills or network deployment are to be supported, but technological developments are required in broadband wireless communications, very high broadband wireline communications, networks interfacing and systems autonomous connectivity, user-friendliness
- With ubiquitous digitalization, cyber-security and protection of the communications is a crucial contributor to a safe EU secure and free society
- Improved transport and energy services, as well as all sorts of system monitoring services (environment monitoring, homeland surveillance, industrial supply chains, etc.) all rely on ever-growing flows of digital information, increasing the need for reliable high throughput communication networks
- Information and communication technologies consume around 2% of global energy consumption, and this is the sector with the fastest growth over past and probably upcoming years. Increasing energy efficiency in Information and Communication Technology (ICT) is crucial

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

- Volumes of data exchanges have been continuing growth in the recent years, while European telecommunication operators have been experiencing a drop. These operators expect improved communication networks to provide them with capabilities for new services and constitute important growth and profitability relays
- Normalization is a very important driver or barrier for telecom-related industrial activities. Being at the top-front of innovation in low layer telecoms often provides a direct competitive advantage
- Concern is growing in society about electromagnetic waves. In the meanwhile, the radiofrequency spectrum is a limited resource more and more intensively exploited. Optimizing wireless networks for minimizing resource use and possible health impacts is getting more and more important

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

- Combination of all relevant solutions to make a better use of limited radio spectrum
- Ensure a tight-integration of network deployment
- Development of very high bandwidth small directive antenna
- Development of broadband integrated wireless network architectures taking advantage of network diversity, including direct peer-to-peer communications, mesh networking, cross-layer design, cognitive networking, etc.
- Integration of multiple communication chips into single platforms to support multiple network connection (cellular 3G/4G, wireless local area network (WLAN), near-field and other short range communication, wireline with Ethernet or optic fibre connection)
- Firmware over the air capability for remote control of software components in wireless networks management
- Development of very high frequency short distance directional communication means, including cost effective stations and low power related processing capabilities
- Leverage sensitivity of spectrum scanning sensor, including through collaborative sensing between different sensors
- Improvement of theoretical characterization and physical layer realization for cognitive radio networks, with sense-and-avoid techniques (as machine learning and/or artificial intelligence) to learn on unused

frequency bands at a given time, optimize spectrum use from wireless communications and develop the concepts for related platforms

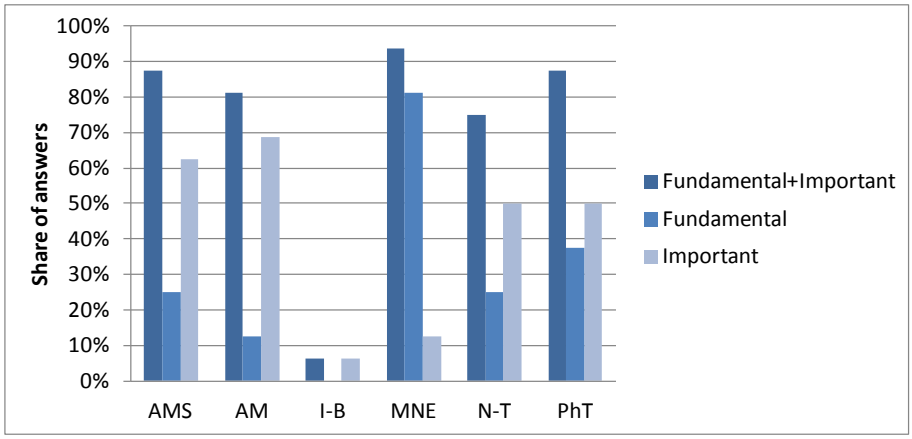
- Use of adaptive waveform to dynamically reconfigure and match instantaneous spectral availability with transmission parameters (freq. band, transmitted power, modulation schemes, etc.) of the radio platform
- Development of terminals and infrastructure for innovative (incl. cognitive) radio solutions (analogue front-ends and digital platforms, antennas and antenna interfaces), including through the integration of radio-frequency micro electro-mechanical systems (RF-MEMS) and of joint combination of sensing, localization and identification for context aware and ultra-low power communication, pro-active context sensitive systems
- Development of open hardware radio platform integrating software configurable elements, i.e. virtualizing middleware, to support re-configurability
- Broadcast spectral traffic digital information for neighbouring nodes, using multiple antenna systems or high frequency selectivity forms of signal (as multi-carrier modulations) for avoiding harmful interferences
- Development of high computational capability low power communication chipsets and modules for RF front end, signal processing, digital processing and handset or other devices accessories (imagers, memories, embedded sensors, localization devices)

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 broadband wireless communication, building on radio-frequency technologies for seamless, high-performance, reliable, interoperable, efficient and secure wireless communication and advanced wireless networks with increased bandwidth and energy efficiency. This may be achieved e.g. by high bandwidth directive antennas, multiple communication chips, and short distance directional communication means.

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:

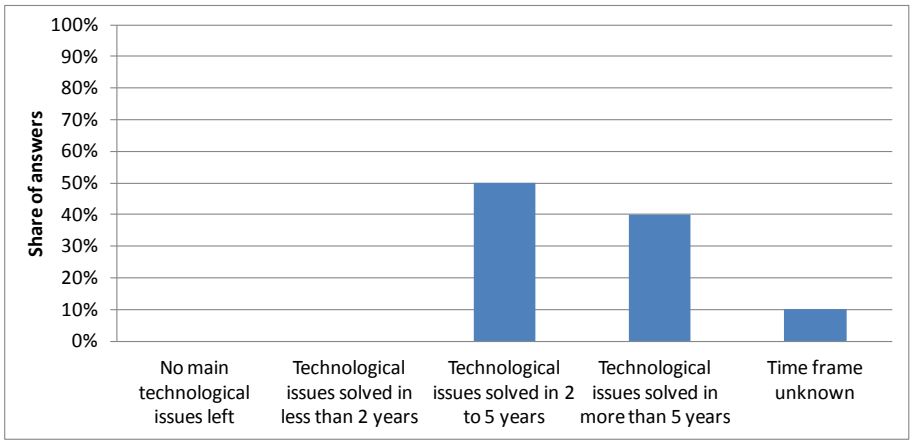
- Micro- and Nano-Electronics (MNE)
- Photonics (PhT)
- Advanced Manufacturing Systems (AMS)
- Advanced Materials (AM)
- Nanotechnologies (N-T)



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

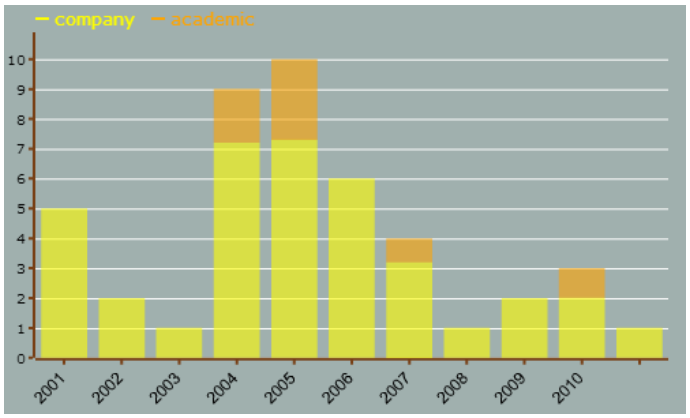
Innovation Field could be solved in a time frame of 2 to 5 years, yet significant consensus by experts indicates also longer periods being necessary:



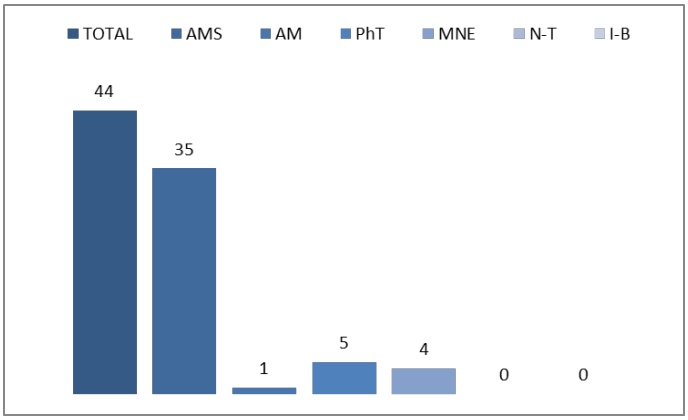
Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the short to medium term should be taken into consideration within this framework.

Additional information according to results of assessment:

- ***Impact assessment:***
  - The quality of service offered by wireless communications has been experiencing continuous improvement, in particular in terms of bit rate (bps) theoretically and practically offered to users. This has been commercially translated into generations of technologies: historical analogue cellular systems, 2nd generation or 2G with first digital cellular, 3G with combining voice and data and allowing mobile internet access and now being deployed 4G with high speed and more flexible connections. 5th generation, 5G, does not exist yet but the term is used to identify future ultra-broadband wireless communication that could support massive cloud computing and the ubiquitous communicating devices of the Internet of Things deployment around 2020. Rather than real generation effects, many technological steps will enable progress – higher data throughputs, automated connectivity, full interoperability between different sorts of protocols, etc. – many of them relying on KET based hardware developments.
  - Increasing bit rates will allow new services based on “big data”, cloud computing, the acceleration in deploying communicating devices, etc. A very wide range of applications will derive from this, from entertainment and social games to smart power grids, smart homes and cities, driverless transports, and many unforeseen services. Related markets are in € billions, and direct industrial impacts are enormous since the whole wireless network infrastructure has to be adapted to the communication protocols in usage. A large part of the industrial capability has been lost by Europe but innovation based on hardware, i.e. KETs, is seen by the telecom sector experts as the main chance of reconquering market shares taken in particular by Chinese players.
  - Possible health impacts, as well as cyber-security measures and privacy protection have to be considered. All these aspects may benefit from defence applications already in use that can be transferred into the civilian domain.
- ***Results of patents scenario analysis:***
  - 44 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Since 2004-2006, on a decreasing and very low trend curve (number of patents per year)



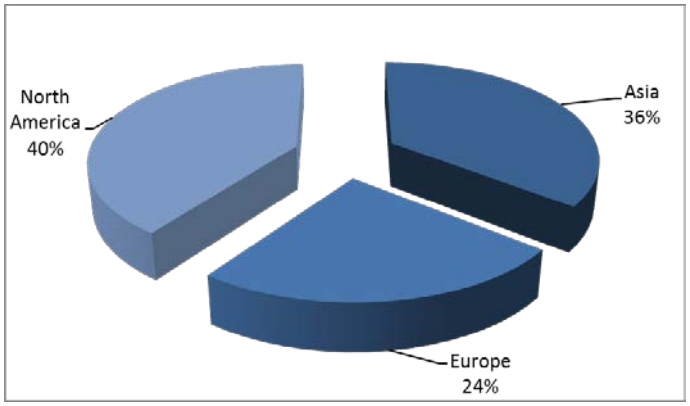
- Patents by KET(s):



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

KET(s)	*Number of patents*
AM	1
AM / PhT	1
AMS	35
MNE	4
PhT	5

- Patent distribution by (Applicant) organization geographical zone:
- Samsung (South Korea) is the dominant applicant in this field, with 9 patent families in the period (20% of the total)



- Patent distribution by geographical zone of priority protection: