Position Paper

To Strengthen European Technology: The Support of RFID within Framework Programme 7

Recommendations to the European Commission

CE RFID
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CE RFID ("Coordinating European Efforts for Promoting the European RFID Value Chain") is a sustainable network of RFID technology providers, vendors and users, which support the European Commission to increase political awareness and intensify activities for the enhancement of this new technology.

Current members of CE RFID are METRO Group, Germany; AIDA Centre S.L., Spain; Deutsche Post World Net, Germany; EADS, Germany; FEIG Electronic, Germany; Pleon, Germany; RFiT-Solutions, Austria; Siemens, Germany; Tyco Fire & Security ADT, United Kingdom; UPM Raflatac, Finland, VDI/VDE Innovation + Technik, Germany; and XNG, Austria.

CE RFID contributes to the "European Technology Platform on Smart Systems Integration" EPoSS which defines future R&D needs, innovation and policy requirements related to smart systems integration as well as to integrated micro- and nanosystems (www.smart-systems-integration.org).

www.rfid-in-action.eu

Executive Summary

RFID is one of the evolving high-tech markets in the ICT sector with an expected volume of 24.5 b USD in 2015. There is a strong RFID industry in Europe as well as a strong potential of industrial and private RFID users. Both, technology providers and users may profit from growing RFID markets and technologies. However, the international competition is strong and Europe suffers from several drawbacks. Most important, there is a lack of European activities concerning standardisation, frequency harmonisation and support of research.

In this paper the Working Group *RFID / Logistics* which is part of *EPOSS* – the European Technology Platform on Smart Systems Integration – proposes to put a special focus on RFID in the Seventh Framework Programme of the European Commission. This RFID focus should be centered around the strategic visions of the 1-Cent-tag and of RFID as a core technology for Ambient Intelligence applications. The objectives of the proposed RFID focus are to strengthen the European RFID industry as well as the industrial users in Europe and to foster the breakthrough of ambient intelligence applications in areas like health care, food safety, and waste disposal with high benefits to the European civil society. The still existing technological challenges to RFID break down into a research agenda containing ten technology fields from the areas of microelectronics, microsystems (resp. MEMS = micro-electro-mechanical systems), software engineering, and radio frequency technology (RF) where mid-term and long-term research is needed. Finally, the working group puts special emphasis on research projects that work towards real world applications and clear benefits for the European RFID industry as well as for European RFID users.

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1 Introduction

RFID (Radio Frequency Identification) technology has become a key technology in the ICT sector. RFID tags identify individual goods and commodities in real time and thus close the gap between the physical flow of things and the related information flow in the IT systems.

It is foreseeable that RFID will be one of the evolving segments of the ICT market. Most promising, the fast development is driven by the users which have organised themselves in the industrial standardisation body EPCglobal. Retailers and FMGC producers have launched first RFID roll-outs. Other industrial sectors like logistics, automotive, aeronautics, and pharmaceuticals are working on the adoption of RFID to their processes. Main application will be the tracking and tracing of goods as well as counterfeiting. The public sector has already set up several RFID-based projects like the E-passport of the European Union or the tickets for the FIFA World Cup 2006 in Germany.

In the long run, RFID is a core technology for ambient intelligence. Using RFID technology, everyday commodities and goods will become "smart objects". Elderly and disabled people will be supported by intelligent implants, monitoring and dosage systems. The close tracking and monitoring of goods in the food chain will improve food safety. Smart industrial goods will store information on their components and their use. Thus waste disposal management will be switched from today's inefficient mass-oriented approach to an individual recycling process.

2 European Competitiveness

There is a strong European standing with respect to RFID technology. Companies from Europe like METRO, Tesco, and Airbus are early adapters which are pushing forward technology development and applications. EU-based technology providers and service providers are playing an important role in the market. This includes big companies like Philips, Infineon, and SAP as well as SMEs like Rafsec, RF-IT, and KSW Microtec. European research institutions like IMEC, LETI and Fraunhofer Society are internationally acclaimed driving forces in the RFID core technology areas RF technology, microelectronics, polymer electronics, and microsystems technologies (MST).

However, Europe has to face also a series of challenges. Within the most important standardisation body EPCglobal European players have still to reach the importance of their US partners. Moreover, European companies face a very strong international high-tech competition. Technology providers like Alien Technology and Hitachi are at the leading edge of technology and do not stand back to their European counterparts. Finally and probably most important, other nations provide strong support to their local RFID industries. The government of South Korea is planning to spend 800 million EUR on RFID research and manufacturing till 2010. The US Department of Defence (DoD) and the US-based retailer Wal-Mart have issued RFID mandates to their suppliers; the US Federal Drug Administration FDA strongly recommends RFID. These mandates push forward the application of RFID in the US, strengthen the national RFID providers and encourage R&D investments in this sector.

In Europe there is no co-ordinated support for RFID technologies including the risk of an immediate throw-back of European RFID industry in short time. RFID applications are most often international applications and need international standards, pilot projects, and research. In order to keep its leading position in RFID technologies, Europe has to build its own European RFID framework with uniform frequencies and regulations and with European R&D activities.

3 Challenges to Research

RFID is still a maturing technology. First pilots and rollouts have shown demanding challenges. First of all, reliability is a major issue. Reading rates must be improved, especially in difficult environments containing metal and water. In general, the reading rate must come very close to 100 % and must be constant and predictable even in volume applications.

There are explicit needs for additional functions by which the tagged objects will really become smart. This comprises a number of components: First temperature sensors on RFID tags have been realised but there is great need for other sensory functions like humidity, shock, velocity etc. Memory size and computing power must be increased in order to add intelligence to the tag. The localisation of a tag within an RFID network is needed in a number of logistic and many other applications. Security and privacy is another big issue for certain RFID applications. This includes the protection of personal data on ID cardsas well as the protection of business-related data on the tag within an open supply chain. For some applications the costs of RFID systems have to be drastically reduced. This applies especially to large scale applications like retail, postal services, and food safety.

RFID has an impact on a series of technology fields. The real-time management of supply chains and of business and administrative processes will overstrain today's centralised IT architectures. Instead, there is a strong need for a decentralised information management in which the smart objects will take over more responsibility for the steering of processes. For the time being RFID tags are most often applied on top of goods and packages which leads to a comparatively complex and costly labelling process and often to a poor quality of the labelling itself. It is still a challenge to let the RFID tags become an integral part of the goods or packages.

Most of these challenges – like data security and decentralised information management – apply to RFID readers as well. Especially mobile readers in small everyday objects, by which the flexibility of RFID networks will be increased notably, are subject to serious constrictions on energy supply and size.

Apart from mere technological aspects two other challenges should also be taken into account. It is essential that R&D results are transferred to international standards. The successful transformation of MIT's research project Auto ID into the industry standard EPCGlobal may serve as an example. European RFID players must play an active role in current and future standardisation processes. Finally, IPR must be considered. Many experts fear that the battle for the most important UHF range is decided by the possession of key patents. It should be ensured that the

RFID industry, especially SMEs must have easy access to key patents, f.i. by means of patent pools.

4 Focus on RFID in FP 7: Strategic Objectives and Strategic Visions

RFID is one of the growing market segments of the ICT sector. The European RFID industry is a strong player in this high-tech market segment. Therefore, the Working Group RFID / Logistics at the European Technology Platform EPOSS asks the European Commission to put a strategic focus on RFID in its Seventh Framework Programme. These activities should follow three objectives:

- to strengthen the European RFID industry by supporting mid-term and long-term R&D works,
- to strengthen European RFID users by supporting pilot applications and by pushing forward European participation in frequency harmonisation and standardisation activities,
- to strengthen European civil societies by supporting the implementation of Ambient Intelligence applications with high societal benefits like health care, food safety, waste disposal and safety and
- to promote the public acceptance of RFID by providing competent and comprehensive information on RFID to the public.

Due to the broad range of challenges the research activities on RFID will span over a range of different technologies. However, the RFID research works within FP 7 should be united by unifying strategic visions. The working group suggests two strategic RFID visions:

- to develop the low-cost and high-quality 1-Cent-tag for mass volume applications and
- to develop RFID as a core technology for Ambient Intelligence where tagged goods and commodities become smart objects able to sense their environment and to communicate to other objects and IT systems as well.

5 RFID: Strategic Research Agenda

In order to reach the objectives and visions of the proposed RFID focus in FP 7 the working group suggests to set up a strategic RFID research agenda which subsumes ten technology fields ranging from microelectronics over MST, software, up to RF technologies. Additionally, the working group proposes to include socio-economic studies into the agenda as well (see fig. 1). These eleven research fields should be considered as building blocks which are combined to realize the vision of smart RFID systems.

5.1 Packaging

Silicon-based tag packaging (which comprises the application of the chip to a substrate, the antenna, and the connection of antenna and chip) is responsible for more than 50 % of the costs. It determines the way how a tag can be integrated into goods and packages and how it must be disposed off after use. There is also a strong need to integrate mobile readers into small objects in industrial and end-user environments. Thus, packaging topics with respect to RFID are flexible and multi-layer substrates, the integration of chips and antennas into non-standard substrates like textiles and paper as well as substrates, conducting paths and bonding materials adequate for harsh environments and for ecologically sound disposal.

5.2 IC Design

To a great extent the design of integrated circuits (ICs) is not specific to RFID applications. However, especially tags for smart objects are asking for future research. In order to reduce the size of tags sensors, energy supply, and RF components must be integrated into monolithic silicon chips ("system on chip").

5.3 Energy Awareness

Energy supply is a great challenge for smart RFID tags with additional sensors and computing capabilities as well as for mobile readers. Tags and mobile reader are not connected to a constant power supply and in general cannot be recharged on time. However, tags and mobile readers should be as small as possible which restricts the space for batteries. Research topics are integrated foil batteries, energy saving algorithms – especially for cryptographic functions, energy harvesting (i.e. energy is gained from the environment by Piezo or other effects), and an energy saving power management of all tag components.

5.4 RF Technology

Due to the usually low power level of RFID tags radio frequency (RF) is an important issue. There is still need to improve the antenna design of both tags and readers in order to gain optimum reading ranges and predictable reading rates. Today, the metallic antenna is by far the largest component of a RFID tag. Research tasks are printed antennas which may be easily integrated into paper packages and antennas which are integrated into the chip itself ("coil-on-chip"). In the case of smart objects which interact autonomously in sensor networks, there is great need to adapt existing approaches to ad-hoc networks to the restricted hardware and energy resources of RFID systems. On the long run, ultra-wide-band communication will gain more importance due to its low power requirements and to its more efficient use of given frequency ranges.

5.5 Manufacturing

There is still great potential to enhance the manufacturing process of RFID tags. The print-like reel-to-reel manufacturing is a standard operating procedure for simple tags but still a challenge for high-quality tags. This includes for instance the handling of thinned (and thus flexible) chips and the assembly of tags consisting of multiple chips or multiple discrete components. Even more advanced are self-assembly manufacturing processes where the explicit pick-and-place of tag components is replaced by mechanical or electro-magnetic key-to-lock placement methods. Another big issue is the long-term convergence of traditional print processes and RFID manufacturing.

5.6 Polymer Electronics

The manufacturing of silicon chips is a complex and costly process. The replacement of silicon by polymer as base material for integrated circuits and electronic components promises a substantial cost cut. Polymer displays can already be manufactured. Other electronic polymer components like batteries or even ICs are still challenges just like the manufacturing on an industrial scale.

5.7 Bi-stable Displays

There is a number of RFID applications which ask for the visual display of the tag data, f.i. in retail or postal services. The energy consumption of existing LCD displays is much too high for low-power tags. Bi-stable displays (which need energy

just for changing the contents of the pixels whereas no energy is needed to maintain the visibility for a given pixel state) are yet a challenging MST issue.

5.8 Sensors

There is a great number of technically established sensor principals. However, even in these areas there is still need for further improvements. This includes for instance their monolithic integration into the chip, the development of low-power sensors, event-triggered sensors and the down-sizing of the sensors to a sub-molecular and atomic level.

5.9 Cryptography

In principle, most privacy and security tasks of RFID systems are covered by standard cryptographic methods. However, in general cryptographic algorithms are too expensive for RFID in terms of both computing time and memory usage. Therefore, standard cryptographic algorithms must be adapted to the restricted hardware and energy resources of RFID systems.

5.10 ICT Architectures

In principle, RFID tags, RFID readers and the backend IT systems are massively distributed, autonomous, and heterogeneous IT systems. However, today's IT systems like enterprise resource planning systems or production planning and control systems are not well prepared to fit into this scheme. The tags respectively the readers provide their information in real-time whereas the IT systems are based on batch or user-driven processing. The task is to define appropriate ICT architectures. This may lead to a shift from the current paradigm of centralised IT systems to a paradigm of decentralised, self-organising IT networks where the smart objects and the readers gain much more autonomy and responsibility.

5.11 Socio-economic Studies

RFID will have significant impacts on society and economics: Privacy is already a major issue for certain RFID systems like ID cards and tickets which may be used to track individuals and their behaviour. The enhanced track-and-trace functions of RFID will reshape supply chains as well as waste disposal and recycling processes. On the other hand, RFID tags themselves must be disposed after use. Matters like these must be regarded carefully for a successful adoption of RFID technologies.

Therefore, there is a strong need to complement the research on certain technology fields by socio-economic studies which deal with matters like new RFID applications areas besides logistics like health care or ambient intelligence, technology acceptance, privacy, environmental aspects, and economic effects. These studies should provide recommendations for public institutions, companies, and NGOs how to cope with the impacts of RFID.

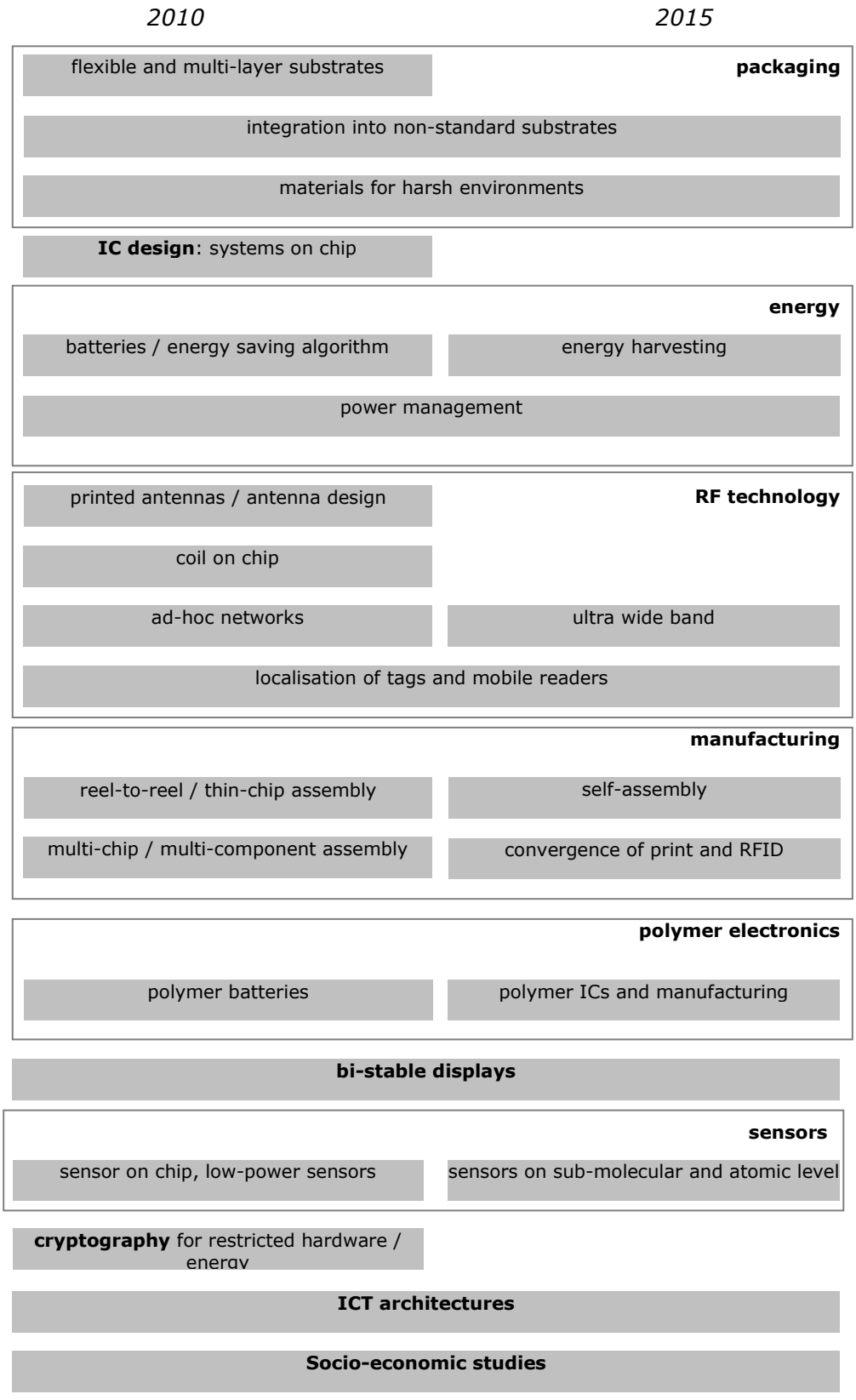

Fig.1: Mid-term and long-term research agenda for RFID

5.12 Recommendations

RFID systems are complex ICT systems. There is no technological silver bullet to RFID. Rather a mix of advanced technologies is needed to design and to realise RFID-based systems for Ambient Intelligence. Moreover, it is essential that the supported projects are determined to work towards real-world applications and towards long-term benefits for the RFID industry as well as for both the industrial and the private users RFID in Europe.

Therefore, the EPoSS Working Group RFID/ Logistics recommends that the European Commission should follow these principles when setting up an RFID focus in its FP 7:

- support multi-technology R&D projects which cover all relevant aspects from microelectronics, MST, software technology as well as RF technology and which follow a systemic approach,

- support RFID projects which span over the complete value chain and which include technology providers, system integrators, and users,

- consider demonstrators and trials as essential parts of supported projects,

- support research on socio-economic issues, f.i. on new application areas, technology acceptance, privacy, environmental aspects, and economic effects,

- support and encourage the standardisation of project results, and

- support and encourage the easy access to patentable project results.