



RFID Technologies: Emerging Issues, Challenges and Policy Options

Executive Summary

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Executive Summary

Radio Frequency Identification (RFID) technology, an enabling technology for automatic identification based on radio waves, will impact the daily lives of European citizens in many different ways. Minuscule devices, called RFID tags are attached to objects and emit information which aptly positioned readers may capture wirelessly. Such tags and readers come in various shapes and forms, have technological capabilities that can open up new application areas and are already in use to improve efficiency and reliability. They also facilitate the coupling of the physical reality to the virtual world, infusing it with digital functionality and triggering the move towards the so called Knowledge Society.

The technology is complex but mature enough for immediate deployment. However, due to its enabling character, it is still under constant evolution – as is evidenced by the increasing number of RFID related patents (65% increase in 2004). The RFID market is still in its infancy with most applications not being large-scale and the forecasted economic benefits (Return-on-Investment) still unclear. However, the technology providers' market for RFID is global and Europe houses a few of the world's strongest RFID suppliers. At the same time the end-user market is specialised in diverse application areas, mainly local and usually dependent on emerging opportunities in the public sector domain. Technology Consultants IDTechEx predict that in 2007 a total of 1.7 billion tags will be sold and that the global RFID market value (including all hardware, systems, integration etc) will be 3.8 billion Euros, rising to 21,3 billion Euros by 2017¹.

Many Europeans already use RFID-equipped cards to access, for instance, their work premises or pay for their public transport fare. The technology is also successfully used for animal tagging, in order to protect the consumers from a host of animal diseases or help them trace their lost pets, and as anti-fraud protection in luxury items. RFID technology is forecasted to spread rapidly over the next decade as soon as tag costs fall enough to allow item-level-tagging. In addition to private sector activities, there are ongoing initiatives both at European and Member State level which demonstrate, on the one hand, an overall comparable activity to that of the US but on the other considerable differences (in magnitude and speed of uptake) among EU countries. Early adopters are expecting to gain considerable experience on which they anticipate commercial profits, while laggards hope to be able to avoid 'teething problems'.

However, the massive adoption of RFID introduces challenges such as concerns over possible eavesdropping over the air interface or over the potential danger of privacy abuses as a result of the ubiquitous, silent and invisible character of the technology. The European Consultation process (over 2000 participants) highlighted the fact that inadequate privacy safeguards will impact acceptance of RFID negatively; trust is thus a major issue. There are also other issues to be addressed at European level: those related to raising consensus on standards, achieving cross-border and cross-sector interoperability and adequate spectrum allocation in order to increase the agility of the market. It is very important for Europe to be prepared for rapid deployment in RFID and also to implement initiatives which will allow European citizens to benefit from this new technology while avoiding the risks it carries.

Objective and scope of the RFID study

A study on “RFID-Technologies: Emerging issues, Challenges and Policy options” was commissioned by the European Commission’s DG Joint Research Centre, Institute for Prospective Technological Studies (DG JRC-IPTS) to further investigate RFID technologies and their socio-economic implications. The study looked at technological, market, societal and legal issues so as to identify and analyse barriers and opportunities for Europe, in order to propose policy options focussing on European citizens' needs. The summary that follows presents the major policy options proposed, a European SWOT analysis, the main issues analysed and the structure of the report that follows.

¹ Data published at: <http://www.the-infoshop.com/study/ix49177-rfid.html>

European SWOT for RFID deployment

The study has identified, mainly through the analysis of the specific application areas, related strengths, weaknesses, threats and opportunities for Europe. Although, it is unlikely that all EU countries will be able to equally benefit from item-level-tagging applications due to the diversity in the structure of their manufacturing sectors, it is expected that they will all be able to profit from human-centred applications. In health, public transport and animal tracking areas, RFID enable the alignment of information processes that allow considerable efficiency gains and improved end-user convenience (e.g. increased safety in the sensitive health area, more efficient supply and use of public transport means, locating animals). Law enforcement is driving RFID take up in animal tracking and more secure travel documents and RFID is expected to have a positive impact on national security and the fight against terrorism. The table below summarises the findings:

Strengths	Weaknesses
<ul style="list-style-type: none"> - Europe houses part of the big RFID suppliers; - High market potential; - Leading EU countries with RFID focused attention (UK, France, Germany, The Netherlands, Italy); - Focus of attention comparable to USA. 	<ul style="list-style-type: none"> - Many European countries with only marginal attention for RFID; - No level-playing field for RFID across countries; - No harmonised frequency policy in the EU; - Vulnerable image of RFID - Trust issue.
Opportunities	Threats
<ul style="list-style-type: none"> - Increasing efficiency of production, trade and services; - Creation of new services, new workplaces; - Spur for economic development - Increased convenience in citizens' everyday life; - Increased security, reliability and trust; - Stimulation of research and development of related technologies (enabling, enhancing and concurrent). 	<ul style="list-style-type: none"> - High initial and high transition costs; - Rapid technological evolution may help displace a technology before it is widely adopted; - High hidden costs (societal and organisational such as for training and education); - Possible job losses due to wide deployment; - If not implemented properly, RFID may bring a number of threats to privacy and security (Function creep, surveillance capacity).

On the other hand, market integration seems to be the first challenge for Europe to tackle while balancing the efficiency gains for businesses with the perceived benefits for citizens emerges as the next challenge. However, Europe's responsibility goes beyond achieving very low cost tags which would enable a future where item-level-tagging is possible; the opportunity comes from developing high-end, added-value market applications promising accurate and actual data-based quality, improved personal safety and security and extensive convenience. The biggest opportunity for Europe in embracing this technology seems to be the realisation of the vision of an integrated physical and virtual world life where RFID technology is the ubiquitous, always-on, seamless bridge to and from both worlds.

Emerging issues and challenges

With RFID out of the laboratory and into the mainstream of business and society, a debate as to the likely and desired implications of the technology on the socio-economic fabric should take place. The study identified a lot of opportunities but also challenges that need to be openly debated. To begin with, the study identified many technical challenges (e.g. in developing advanced RFID tags, linking to wireless networks, merging with sensor devices, improving reliability, setting standards, and testing

and certification) and some market ones (e.g. high initial investment costs, uncertainty as to which standards or which technologies will persist, adoption issues as a result of low trust, etc...). Nevertheless, the study would like to draw attention to a number of issues for which consensus will be needed before decisions on the scope and the focus of future initiatives may be taken. Some of them are described below:

1. Currently, a major drawback to wide-spread deployment of RFID systems is the overall attitude of people towards them. In general today, **social acceptance and trust of RFID** is quite low – as a result of insufficient privacy and security safeguards and also the lack of awareness – and may impede take up of RFID technology. However, it is not sufficient to make the technology secure and reliable. The perception of security depends on the individual's reaction to both the risks and the countermeasures adopted. Individuals will need to be appropriately educated if their perceptions are to closely match deployed RFID security reality.
2. **Ethical issues** are also at stake (e.g. over the use of RFID implants) and the development of European good ethical practice is a first step towards addressing them. Due to the complexity of advanced RFID systems, a process needs to be defined which will identify and counter emerging security and privacy threats, prior to the deployment of RFID systems.
3. The foreseen wide-spread use of RFID applications and its enabling capacity raise various **security and privacy concerns**. Most of them are being dealt with through improved technological design, taking into account security and privacy throughout the value chain and also by judging the sensitivity of the case to security and privacy issues. Various initiatives, at EU level, to tackle RFID privacy and security concerns already exist; for example, the Article 29 Working Party has expressed its views on minimising data collection and preventing unauthorised forms of processing through improved use of the technology. However, it is the appropriate mix of self-regulation, through the creation of codes of conduct and of legislation that would need to be enforced that is at the heart of the debate on further initiatives required.
4. The **impact on employment** is not clear and should be monitored. Pessimistic forecasts say that deployment of RFID technology may result in about 4 million job losses (over a 10 year period in the US). However, no major disruption of the labour market is expected, apart from the forecasted shortage of skilled professionals which will impact rapid deployment. Moreover, RFID will create new jobs, related to data processing and service-related jobs and the overall resulting economic growth may also contribute to the creation of additional workplaces. It is clear that training activities will be needed as new kinds of skills will be required both for professional workers (development) and end-users (customisation).
5. High initial costs for setting-up RFID systems, uncertainty on the future of the most promising technologies of today, the lack of well established standards and finally hidden societal, and organizational costs (e.g. training) are well-known **barriers for smaller companies** which are reluctant to adopt the technology.
6. Dependability of RFID information systems, especially in sensitive application areas such as health, signals the need to design appropriate **fallback procedures** in case there are system failures. This obviously adds to the costs of deployment and represents yet another barrier.
7. There is a clear **gap between leaders and followers** in RFID adoption in Europe. This may limit the foreseen benefits of a larger European market and constrain the development of high-end applications which promise to enable a new generation of services for citizens. Moreover, closing the gap has positive growth implications as 'local' European firms will play an important role in the challenging ICT transformation processes that RFID brings.
8. The direction a European harmonized frequency policy should take is still under debate. However, the question as to whether **reserved spectrum bandwidth** in the EU will be sufficiently large for future applications is already important. For comparison purposes, the US administration has reserved bandwidth that is 10 times larger.

9. As a result of the wireless and invisible nature of RFID information exchange enhanced **testing and certification** procedures are needed in order to ensure that, for example, requirements concerning privacy and security are fulfilled (e.g. kill command works according to specification). A vendor-neutral solution to the establishment of certification of providers, approved system integrators, RFID consultants and trainers is needed.
10. Although there are many available technical standards (ISO, EPCGlobal), **semantic interoperability** is also needed so as to allow the structured exchange of information in RFID-based systems as information is application specific. This type of standard would increase usability of information stored on tags and produced by sensor networks. Insufficient semantic interoperability of RFID systems may restrict benefits from their deployment, especially for globally operating systems.
11. RFID systems produce a lot of data locally and collision avoidance is a practical requirement that needs to be addressed. Advanced RFID systems, serving geographically distributed needs, generate **huge amounts of data** which are difficult to manage in real time and which are expected to create a new burden on the global network infrastructure; especially when the system architecture foresees centralised data storage. Moreover, in today's complex business processes where the value chain is composed of different companies, issues related to data ownership, control and liability will need to be addressed.

Proposed policy options

The study looked at a number of RFID issues in general and also focused on the analysis of five selected application areas (animal tagging, healthcare, public transport, identity documents and the ICT sector) where implementation in Europe is well advanced, in order to draw conclusions as to what is at stake for Europe. As technological evolution is continuous, achieving a balance between reaping the benefits and avoiding the pitfalls associated with its implementation is inevitably a moving target. Given the enormous socio-economic potential of this particular technology, a debate on what role Europe should play in this areas has been launched. Whatever the result of this debate, Europe ought to tread a fine line between issues that are considered to be of vital importance for the market players, and the interests of the citizens. Moreover, the EU should take up this opportunity to drive the realisation of the vision of a European Information Society where services integrating the real and the virtual worlds are on offer.

Bearing in mind that there are various intervention instruments (technological, legal, or through stimulation of self-regulation) at the disposal of the policy maker, the study presents the following policy options:

1. Europe will benefit from stimulating cross-border take up of RFID applications primarily through setting-up a harmonised frequency policy and then through stimulating consensus on standards and interoperability issues. Moreover, promotion of best practice, financial support of cross-border pilot and trial programmes, and fostering SME participation in the area will contribute to helping fight market fragmentation and bringing all EU Member States closer to the European Information Society vision.
2. The Internet of Things (the billions of tagged objects that will enable access to back-end information systems) will require a service for registering and naming identities, the Object Name Service (ONS), which should be interoperable, open and neutral to particular interests. Europe should position itself in the appropriate international fora to exercise its responsibilities in this area.

The report has also identified the need to establish a debate on RFID in Europe as well as the need for further technological and legal research as primary recommendations for action.

1. European society needs an information campaign on RFID systems to raise awareness as to the likely benefits and possible risks of the wide-spread application of this technology. A debate should also be launched with a view to making the preferred and ethical use of the technology more explicit to all.
2. A closer look at the existing legal framework is deemed essential. Further study is also needed to develop a process for establishing guidelines and best practices which aim to build safeguards against emerging RFID risks.
3. As a result of the enabling character of the technology and its multi-sensor data integrating capabilities, there is a clear need for further technological research to improve efficiency, robustness and security. More research will be needed into:
 - a. advanced tag-reader systems;
 - b. the enhancing of security and 'privacy by design' for complex applications;
 - c. the impacts of almost permanent exposure to very low intensity radio waves produced by ubiquitous always-on RFID devices;
 - d. the re-skilling of the professional population to foster market expansion;
 - e. how to foster creativity and innovation spirit to help create additional and more advanced links between the physical and the virtual worlds.