
RFID from production to consumption

- Risks and opportunities from RFID-technology in the value chain

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Preface

This report presents results from a project on the opportunities and risks associated with RFID technology prepared by The Danish Board of Technology.

The Danish Board of Technology (DBT) is an independent body established by the Danish Parliament. It aims to further the technology debate, assess technological impacts and options and advise the Danish Parliament and the Government.

DBT has chosen to assess the use of RFID at a time when the use of the technology is still in its infancy, yet while its trajectory is being plotted out. The project focuses on the value chain, from the production to the consumption of goods, because a massive penetration of RFID in this sector can be expected in the future – probably within the next 10 years.

The project was completed in cooperation with an expert group including the following members:

Anette Høytrup, lawyer, The Danish Consumer Council

Christian Wernberg-Tougaard, Director, Unisys

Henning Mortensen, Consultant, ITEK / The Confederation of Danish Industries

Michael Østergaard, PhD-student, DAIMI, University of Aarhus

The aim of the project is to break down existing myths, trigger new perspectives, and suggest guidelines for the use of RFID technology. A selected group of stakeholders has participated in brainstorming and analyzing the myths and perspectives of the RFID-technology, based on a written material describing different scenarios of RFID application and the dilemmas of the possible use (this material has not been translated into English). The participants at this workshop comprised representatives from various parts of the value chain: development, consumption, production, logistics, industry and other stakeholders. The results of this workshop are summarized in this report.

On the basis of the stakeholder analysis the four members of the expert group has agreed on **five principles for the future use of RFID**. These principles, which are presented in the first chapter of this report, should in their opinion serve as guidelines for a balanced implementation by addressing first and foremost the huge concern on privacy. In the Danish report the principles points to necessary action on both national and European level. In this translation the recommendations pointing to the specific Danish context has been removed or shown in parentheses.

It is the hope of The Danish Board of Technology that this report can give inspiration to the current discussions in various European forums on the future use of RFID.

Copenhagen, June 2006.

*Ida Leisner
Project Manager*

Five principles for using RFID-technology in the value chain

RFID carries great potential for developmental strides for individuals and the society as a whole. The vision of the planning committee is to see how RFID technology can be developed in a way that it complies with common ethical principles for privacy, security and user-friendliness. Especially we find it important to take personal integrity (privacy) and usability into account. We must make it easier for the private enterprises and public sector institutions to implement solutions on the basis of lasting security concepts. In our view these issues must be addressed while RFID technology is being developed and implemented. Therefore we have identified five principles, which reflect the basic preconditions for the future use of RFID. The expert group is of the conviction that the use of these five principles will help ensure forward-looking developments in the use of RFID with a built-in respect for personal integrity.

RFID will be an essential component in the future, and has the possibility to change many of the ways we do things today. It is one of the most promising technologies that – assuming it is implemented with care – will be able to produce uncountable possibilities throughout the value chain from the producer to the consumer.

In the business world, transparent logistics can transform business processes and encourage greater efficiency in production and inventory management. The retail branch will be able to acquire information about sales, the status of goods and losses in real-time, all this without having to manually count the goods.

For consumers, RFID in all types of goods will open the door for totally new integrated services and products, for instance, information about goods and proof of authenticity. The user will be able to get information about the vitamin and mineral contents of a salmon fillet right at the fish counter, and be alerted to the presence of allergy-provoking agents found in the products they might buy. For the public sector, RFID can play a role in identifying and controlling materials coming through the national borders; something which is particularly desirable in food security arena. The opportunities are endless when information about every good's "life" is not lost as it changes hands, but rather follows the product throughout the chain, from cradle to grave.

To ensure that companies, consumers, and the public sector can take advantage of the benefits of RFID technology, in a way that lives up to the values and norms normally held dear, the planning committee under the Danish Board of Technology wished to point out a number of principles to be accounted for in the use and availability of RFID technology. Politicians, interest groups, and other decision- and opinion makers should take care to bring these issues up in their respective forums that, now and in the following years, are establishing the criteria and standards for the use of RFID. This includes OECD, EU and various standards institutions (ISO, EPC Global, W3C, ETSI, IETF, IRTF, TACD).

There is a clear need to provide information to consumers and companies alike, in retail, logistics, production, about the development of RFID as well as the opportunities and consequences associated with the technology. Consumer and business organizations should go forth in setting the RFID agenda.

Taking advantage of RFID technology's numerous possibilities, also involves a number of risks which require assessment before the technology is diffused throughout the value chain. The most ominous risk is that of misuse: that the technology is used in ways beyond that of making transactions simpler, developing new services and improving efficiency. The misuse of RFID includes threats to personal privacy and security and can be attributed to the fact that RFID tags can be identified without physical contact. In its current form, the opportunity for surveillance is more theoretical than real, however, the risk grows

every time developers increase the distance from which the chip can be read. A plausible scenario is that everything that one wants to monitor, can be monitored – all goods in a store or a warehouse can be read in a few minutes, industrial espionage, personal persecution of citizens, etc. To defend ourselves against these future misuses, we need to think long and hard about our choices today.

RFID is not yet mature enough for widespread, homogeneous diffusion, and for precisely this reason, it is important to engage in a debate about the technology now, while it is still possible, and while *prevention* is still relatively inexpensive. By trying to anticipate the undesired effects of the technology now, we can hopefully avoid the unnecessary costs of *curing* the problems that arise; problems that will be of a proportional magnitude to the diffusion of the technology. Only through the prudent and early use of these technologies will EU and the member states be in a position to lead and demonstrate exemplary use of the RFID technology.

The five principles and supporting recommendations

These five principles, which the planning committee finds to be bearing pillars for the future utilization of RFID technology in Denmark, and the EU at large, are:

1. The user's control of the technology
2. Personal integrity
3. Interoperability
4. User-friendliness
5. Sustainability

The principles are to be thought of in relation to one another – none of them should stand alone when discussing RFID tags that will reach the end consumer. These five principles with subsequent recommendations will be expounded upon in the following subsections.

January 2005, the article 29 working group in the EU published a document concerning the challenges to protecting personal data in relation to RFID technology¹. The working paper that since has been sent for perusal by various stakeholders, also gives some possible answers to the challenges. The principles from the expert group under the Danish Board of Technology, are generally in line with considerations made by the Article 29 group.

1. The users' control of RFID technology

The privacy problem in relation to consumers, should be solved technically by including privacy in the planning and architecture of RFID, so that the user / owner of the RFID tag unit has full control over which data is sent from the tag, and is thereby undisputed in deciding who can collect what information about the goods the consumer is carrying. In this way the consumer is, at any time, able to control the information sent and hence the data aggregation and linking that can occur. The protection of privacy is needed because an RFID tag can otherwise send its data in clear text, just as soon as an RFID reader asks for it. The users' privacy must, from the very start, be protected; yet in a way that the user can deactivate it and later in a store or at home, select between tailor-made services / functions. The so-called "opt-in model".

¹ http://ec.europa.eu/justice_home/fsj/privacy/docs/wpdocs/2005/wp105_en.pdf

To advance the development of technical solutions for the privacy problem, it may be necessary to assess whether or not the existing legal framework is adequate to protect users' rights to privacy. A pull effect can be created by demanding technical privacy-solutions as a precondition for the sale of RFID tagged goods to public sector institutions (c.f. the precondition surrounding the 'e-invoice'). It should be clarified whether such standards would go against the EF-treaty concerning the free movement of goods.

Technical privacy protection (e.g. encryption) is still expensive and difficult to use, but this would change should RFID privacy become the standard (and here, legal standards and administrative changes would promote the standard). Following this point, it is uncertain that the technology will be significantly more expensive than that lacking a privacy function. Demand will rise for the privacy enhanced chips, economies of scale will follow technological developments, and – ceteris paribus – begin its trajectory, eventually making the tags cheaper.

1.1 Privacy is built into the RFID architecture

- The public sector should support research into the protection of privacy in RFID tags and infrastructure to create a more secure model for RFID-privacy.
- The public sector should take advantage of its purchasing power to demand that all goods are tagged and that the tags are used in a way that secures citizens' rights to privacy.

1.2. Transparency via better information

- The user should be able to get reliable information from the use of RFID about the various politically determined conditions for each type of good (e.g. information about the date of production / packaging, contents and transport). From here, further information can come from the market itself (a description of the good, references to product tests, etc.).
- Information campaigns should be initiated to break down the myths (optimistic and pessimistic) around RFID found amongst consumers and companies.

1.3 The RFID tag should never be automatically destroyed.

- In order to obtain all benefits from the RFID tag (for example in the case of food safety and quality control – product recalls in particular), they should not be destroyed at any point after entering the value chain. Rather, the user, at their discretion should be able to destroy the chip or ask the seller to destroy it.

1.4 The tag should be inactive when the user does not have control

- The user should always be privacy protected. In the case that a tag is sending unprotected information, the user should be able to demand that the retailer deactivate or destroy the tag.

2. Principles concerning personal integrity should be observed

The Declaration of Human Rights protection of citizens' personal integrity, the principles in OECD's Fair Information Principle and EU's personal data directive must naturally be maintained during the implementation of RFID technology. It is possible that there is a need to adjust the personal data directive so that it includes the new possibilities for managing personal data that RFID implies. Furthermore, it is desirable that RFID users have a say in determining common rules for using the technology.

2.1 Guidelines for the use of RFID should be created by consumer and business organizations

- Manufacturing and retail business organizations, as well as consumer groups, within the framework of their respective European parent organizations, should be required to develop a set of EU guidelines for how RFID is ushered into the lives of consumers. The guidelines can sketch out requirements for appropriate signage and marking about RFID tagging and RFID

readers, information about the collection of customer data, requirements of user-friendliness (c.f. 4. principle) and how the protection of personal integrity is ensured (e.g. how Opt-in works and which options users have).

2.2 Consumer and business organization should develop “best practices” for RFID use

- A multi-disciplinary, public-private committee should be established that could investigate needed measures concerning standards, technologies, privacy and consumer protection for the future use of RFID (in Denmark – but possibly also an idea for Europe).

3. Interoperability – the technical systems must be able to intercommunicate

The development of parallel RFID systems that cannot “talk to each other” is undesirable and should not be supported. The overarching global goals of the system should be the same, while it should be up to the individual developers as to how the goals are met. Using a common metaphor, one could say that the “tracks” for RFID should be the same, following a global standard, while the “trains” used on the net can be different, as long as they do not sabotage the use of the net. In developing the basic elements of RFID architecture, we can draw on the experiences from the Internet, where open standards, (primarily the so-called ‘protocol’ TCP/IP, that is used to communicate), were the foundation for the net’s global diffusion. To ensure interoperability, commonly known and internationally accepted / certified standards for RFID protocols must be developed at European level. (Seen from a danish perspective it is essential, that national governmental decision makers and stakeholders participate actively in this process).

3.1 Implementations should be interoperable

- The technical RFID architecture should be based upon open standards so that different systems – proprietary as well as open – can function together directly.

3.2 The international standardizing around “the Internet of things” should be open

- One of the major questions surrounding the control and access to information on the Internet concerns ICANN’s role – in the RFID arena there is a similar problem for “The Internet of Things” in that EPC-global intends to create one global information structure. Here, in relation to securing future services, it is important to anchor future development in openness and global applicability, as well as guidelines for who receives access to *which* data.

4. User-friendliness

Requirements for user-friendliness must be demanded of the RFID technology so that its utilization is simple for the user. If the technique is not accessible for all, there is a major risk that the opportunities provided by RFID will go unrealized. This principle mitigates the risk of “lock-in” where users, firms, and the public sector are either forced to continuously employ a less-than-optimal solution, or worse, avoid the technology altogether.

4.1 Understanding, management, accessibility, control

- The user should be able to intuitively manage and understand opt-in and opt-out options on RFID tags. It should be accessible, so that the user gains real control over their daily use of the technology. The user’s privacy should be protected by as a rule. It should not be necessary that the user go through any form of specific or complex procedure in order to take advantage of privacy protection.
- The use of open standards can ensure that the user receives easy access to the information that is stored on the RFID tag.

5. EU must support sustainable RFID-tags

The amount of copper used in RFID-tags alone gives rise to a potential environmental disaster when the tags are discarded, and therefore public and private organizations must have *preemptive* strategies to manage this problem – for example, through the sorting of garbage or by developing environment-friendly tags. One study from Germany shows that the total replacement of today's barcodes with RFID tags would contribute to 20,000 extra tons of garbage per year in Germany alone.

5.1 Preemptive tag management plan and assigning accountability

- Action plans must be drawn up, requiring that RFID tags are managed according to the same guidelines as electronic waste; this can however be adjusted as to meet the times and version of RFID tag, assuming developments make them more sustainable. Furthermore, regulations should be set throughout the value chain, assigning responsibility and accountability for the disposal of the tags.

5.2 Support the development of environmentally friendly alternatives

- Research into developing alternative tags, constructed from environmentally neutral or decomposable materials should be a requirement of tag development. This can be supported by preferential subsidies for sustainable tags.

The Perspective Workshop on RFID in the Value Chain - Summary

The planning committee's principles and recommendations in the above section are based on the perspective workshop held under the course of the project.

The goal of the workshop has been to break down existing myths, explore new angles, and suggest guidelines for the use of RFID technology.

In total, 32 people participated in the workshop. They were selected on the basis that they represented current and potential users of RFID technology in the manufacturing and retail branches, consumers groups, IT stakeholders, technicians, and privacy concerns.

By including numerous perspectives on RFID, it was possible to identify opportunities and risks associated with the technology at various levels in the value chain.

The participants were asked to discuss the following questions:

What is needed to ensure the most desirable development and use of RFID technology throughout the value chain? Which areas require most attention in order to optimize opportunities, while minimizing risks and avoiding pitfalls, and how should we intervene?

The participants answers can be collected under three categories:

1. Privacy and security
2. Standardization
3. Research into and development of RFID's possibilities

The participants' answer to *what should be done* is briefly presented below. In addition, the participants reflected upon opportunities associated with RFID technology, expressed their skepticism, and addressed the myths. These reflections are also summarized here.

1. Privacy and security

All participants held privacy and security as being particularly important, both for firms and for individuals. Without privacy solutions, tagged products should not be introduced in the consumer market. This will block the way for taking advantage of notable gains in e.g. quality control of food goods.

The privacy issue can however be addressed by incorporating it early on in the technical RFID architecture. Though, the development of privacy solutions requires economic resources and guidelines with which they can be supported. Furthermore there is a great need for guidelines and regulations to protect privacy- an area where governmental bodies must take the initiative. There should be guidelines for the acceptable use of customer / personal data and respect for those who wish to keep their data private. The participants in the perspective workshop pointed out that it is uncertain whether or not the existing Danish personal data law, based on the European data protection directive, is sufficient to protect consumers following the collection and handling of their data via RFID.

Privacy can be improved by:

- Guidelines / subsidies / incentives for the development of privacy solutions
- Incorporating privacy from the beginning in solutions and architecture, RFID tags with a 'privacy mode'

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- Consumer control: The ability for user control over the RFID tag, giving them the ability to decide if it should be active or passive, OPT-in (option) of registering customer data and new services, marketing.
 - Privacy as a competition parameter
 - Investigate the current legal framework (personal data laws, marketing laws) to find out if they cover and ensure the necessary regulation and control needed to address privacy challenges posed by RFID.

2. Standardization of protocols

The development and implementation of RFID in the value chain has until now been driven by major market players such as Wal-Mart, and the international organs for standards have been following suit. The participants in the perspective workshop therefore found it crucial that Denmark secure its interests and seek political influence in the standardization practices.

Initiatives that can bring about transparency and avoid monopolization:

- The use of open standards
- Governmental bodies must be proactive and engage in the standardization / development, and work for a safe and coordinated infrastructure

3. Research and development of RFID possibilities

Many of the participants in the perspective workshop, particularly the representatives for the consumer groups and the retail branch, were unaware of the possibilities with RFID. Simply because there is still very few of the possibilities, which are often described, that are utilized in practice. Certain industrial sectors have embraced the technology, but even here, the possibilities can be exploited further. Many companies are unaware of RFID and hence there is a need for supporting their strategic implementation of the technology, in particular export firms, which export to markets / customers where RFID tagging may soon be required.

Therefore the need to research and experiment with the use of RFID, to uncover the opportunities and risks is strongly underlined by the participants. It was also stated that Denmark can play an important role as an innovative first-user of RFID. User-driven innovation can ensure that input from users, who in the end must live with the technology, can be rapidly built in to the technology when it arrives on the market.

The following areas were explicitly mentioned:

- How information is bound to the products, the quality assurance of the information, consideration of convenience and weak user groups.
- Business cases that show how we can make money via the utilization of RFID tags from producer to consumer. For example, the sale of services.
- How the RFID infrastructure can be adjusted for various user situations, so that we avoid a 'one size fits all' throughout the value-chain. As an example, we can seek technical solutions that limit tracking.
- The step-by-step implementation of RFID in the consumer link of the chain.
- User-surveys and user-centered innovation. As an example, the user can be involved in quality assurance and information sorting, declaration of goods, knowledge sharing between users, etc.

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- Establishing a competence center, where all stakeholders (logistics, producers, consumers, retail, manufacturing, developers, etc.) can engage in dialogue and share their experiences, give feedback to developers, and adapt the technology to the life-situations of users.

4. Possibilities with RFID

When first the physical RFID infrastructure is in place, the technology will open the door to countless information possibilities. When all goods have a unique number, it becomes possible to describe the good, in all imaginable detail: contents of vitamins, minerals and chemicals; the shocks, bacteria, and temperatures that the product has experienced on its travels; GPS coordinates of its source of origin, transport time, etc. With food goods – particularly fresh goods – the technology will make it possible to greatly improve the security and quality of goods, when i.e. date markings can be precise and impossible to change. Furthermore, recalls of infested or spoiled goods will be much more effective as it will be possible to identify precisely which goods must be recalled.

One of the clearest benefits of RFID is that it can be used to create transparency around goods. It will become possible to compare prices more easily but also compare goods on a greater number of qualitative factors. Various consumer groups, such as those with allergies or those concerned with their weight can, with the support of specialized product information, find goods that match their profile. Beyond this, a wealth of services can arise based on the history of the good.

Another aspect of transparency is that all goods can be traced back to their creation, which will give consumers much better information and a foundation to make an educated purchase on factors other than price. Another positive aspect is that forgotten goods will be easier to find as they can “show themselves”. Fraud and swindle through the sale of fake goods will be much more difficult as the unique tags will help guarantee that the good is genuine. Finally, it will also be much easier to find lost valuables.

With RFID in everything, it will be easier to create user profiles and thereby also much easier to target advertising. On the whole, logistics and retail branches, as well as consumers will be able to benefit from the transparency of goods. The retail branch will be able to optimize inventories with better knowledge about which goods sell, and when they are most easily delivered. Situations where an item is sold-out can be minimized while with the inventory is kept at a minimum. The same holds true for industry where the “just in time” principle can be further optimized and inventories can be reduced. In the logistics link, new opportunities for tracking goods will mean less loss. At the same time, identifying the contents of containers can save resources; without even opening the doors, it will be possible to know what is inside.

The empowerment of consumers is a field that has major potential in relation to RFID. If users are adequately trained to use the technology, it will create a possibility for consumers’ preferences to be met in a much greater way than is the case today. With greater insight into goods, the consumer will be able to select goods and products (voting with their wallet) in a more precise way and create new demand patterns. Furthermore, the empowerment of the consumer could create demands that consumers will have the same ability to use their customer profiles, as the stores/retailers and producers have. Finally, the consumers will also be able to sell additional information in their profile – i.e. political conviction, income, postal number, etc, should they chose to do so.

A lingering question however is *where will these services come from?* Maybe they will arise from a wealth of small producers, who provide services in tact with consumers own product reports. If this development should be supported by the public sector, or if it should be a pure market-driven phenomenon is an open question.

5. Myths and skepticism

Skepticism about RFID technologies' penetration in the value chain can be primarily attributed to the concern of massive investments required to adapt existing systems, from producers to consumers; the registration of goods (RFID tags must be registered and set on each good), renovation of stores (new shelves, changing the conveyor belts out with check out *zones*), new payment methods (changing out stamping machines at stations, and cash registers in stores) etc.

Many participants pointed out that it is not always possible to see what the advantages of RFID are in relation to traditional bar coding and product labeling; particularly after the recent advancements in barcode technology. There are still few convincing arguments to justify widespread implementation of RFID, particularly in stores and household products. There is a common desire to 'see what happens' and go with the flow, concerning the developments at the current time.

Another major question was if the information supply expected to come with RFID would be a positive experience for all. It may create an 'information overflow', something which can induce stress for many. The consumer may find it difficult to choose when so many options arise; stores will require large systems to process data, should they care to use the technology for its abilities to produce e.g. statistics about purchases, inventory, time on the shelf, and sell-out analyses, etc. The question is if more information possibilities are an unequivocal good, or if it complicates life for consumers and the small retailer. Do users really desire all this information and selection? Does RFID contribute to creating inequality between users – in part between segmenting the 'good' and 'bad' buyers, in part if some users are able to gain more from the technology than others? Can RFID be one more strike against small stores that don't have the possibility of using the new techniques, and hence closed out of markets by large chains?

Finally, there was major skepticism if it even makes sense to speak of RFID tags on all goods today. We must differentiate between the actual use of RFID and a futuristic vision of "the Internet of Things" with tags on everything. The big questions are then, who should drive the development, which technologies are we speaking of, and who is going to cover the costs?