RFID FUNDAMENTALS

INFORMATIONSFORUM RFID

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FOREWORD

In recent years, radio frequency identification (RFID) has become increasingly important. Whether the area of application is logistics, trade and retail, or leisure-time activities, the technology is changing processes in many areas and creating new service opportunities. For example, RFID transponders attached to shipping units make it possible to improve product traceability. In public institutions, RFID access cards make for quick and efficient admission control.

CeBIT 2006 showed just how important RFID technology has become. For the first time, the leading international trade fair for information and communications technology created an exhibition area exclusively for RFID. Visitors to the trade fair were impressed by the technology: a survey revealed that 90 percent said they expected RFID to become established in the marketplace. The survey was conducted by the IEB (Institute of Electronic Business) for the Informationsforum RFID. Eighty percent of those polled said they expected the technology to optimize processes and approximately 70 percent said they thought it would lower costs. The visitors to the trade fair saw the greatest potential for RFID applications in logistics, in trade and retail, in the security industry, and in production. Half of all respondents said they expected RFID technology to make everyday life easier. More than 80 percent of them, however, thought that the benefits of the technology were not being demonstrated clearly enough.

The Informationsforum RFID has taken on the task of closing this perceived gap regarding the benefits of the technology. This brochure is part of this effort. It will introduce you to the technology's functions, its areas of application, and its potential. We believe that better understanding of RFID provides the foundation for a fact-based dialogue and broader public acceptance of the technology. RFID will be able to establish itself in the market only when consumers understand the value of it. This acceptance must be achieved before consumers and companies can begin to profit from the multi-faceted applications of this technology.

Andrea Huber

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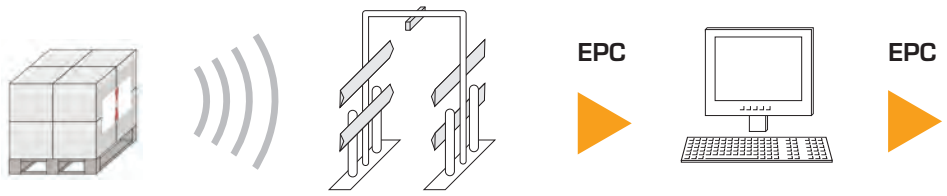
WHAT IS RFID?

RFID stands for radio frequency identification. Thanks to this technology, data can be transmitted via radio waves without physical or line of sight contact. An RFID system infrastructure consists of a transponder, a reader, and an IT system running in the background. The heart of the technology is the transponder – a tiny computer chip outfitted with an antenna. It is integrated into a carrier object – such as an adhesive label or a plastic card. Generally, a number code is stored on the chip. The code encrypts information stored in a database. This process gives every object containing an RFID transponder an unmistakable identity.

Linking of codes and information

Special readers are needed to receive the stored information. This send-receive-unit produces an electro-magnetic field that is picked up by the antenna on the RFID transponder. The transponder then transmits the number code to the reader. Depending on the frequency, transmitting power and local environmental conditions, the read range of the data can be a few centimeters to several meters.

Information about objects can be stored in a manner similar to the way in which information about persons or companies can be presented on their home page on the Internet. For this the reader transmits the combination of numbers to the database. The IT system decrypts the code and links it to information stored in the database or on the Internet. The system's knowledge, or intelligence, is located in the database, not in the transponder.



Information through comparison of the number code:
- Supplier, producer
- Supplier and article number
- Etc.

1 Pallet/carton with an RFID transponder
- Transponder contains number code

2 Portal with readers
- Readers receive the transponder's data

3 Middleware
- Software that links readers to existing IT systems
- Data processing and filtering, transmission to the merchandise management system
- Management and monitoring of the readers

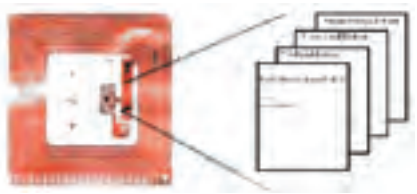
4 Merchandise management system
- Recording of the information in the merchandise management system

Information in database
(data on network)

EPC transponder
- Simple and low-cost transponders
- Write once, read many
- Central data storage
- Clear product identification
- Uniform data standards

Information
(data warehouses)

Information on transponder
(data on tag)



Smart tags + aware objects
- "Intelligent" transponders
- Write many, read many
- Decentralized data storage
- Large amounts of information
- Additional functions and sensor technology

Management
(real-time logistics)

Information can also be stored on the chip. In these applications, the readers need not be linked to a database. Rather, decentralized administration and control are possible. A further benefit is that it is generally easier to alter data on the chip than in the system. The disadvantage, however, is that the reading process takes longer and the transponders are more expensive.

There are various types and sizes of transponder. Depending on the area of application they can be either active or passive. Active transponders are equipped with their own batteries. As a result, the data stored on them can be read at a greater distance. These transponders are used in areas such as electronic toll-collection systems. Passive transponders do not have their own power source. They draw their power from the reader's electromagnetic field.Their read range is relatively short. However, they are much less expensive and lighter than active transponders. Passive transponders are designed to optimize logistics in trade and retail and in the consumer goods industry.

WHAT IS THE DIFFERENCE BETWEEN ACTIVE AND PASSIVE TRANSPONDERS?

	Active	Passive
Power	Battery	Radio waves
Service life	Linked to battery's service life	Unlimited
Price	High	Low
Storage space	Large	Small to medium
Write properties	Several times	Once or several times
Read range	Far	From a few centimeters to several meters
Read rate	Medium to high	Small to medium

FREQUENCY: CRITICAL PARAMETER OF AN RFID SYSTEM

RFID systems use radio waves to transmit information and power. Similar to radio, which uses ultra-high frequency, medium frequency, or low frequency ranges, RFID applications also employ various ranges of radio frequencies. Generally, RFID systems use low frequencies (around 125 kilohertz), high frequencies (13.56 megahertz) or ultra-high frequencies (860 to 960 megahertz). The chosen frequency depends on the type of application, because the various frequencies have their own individual characteristics – particularly in terms of read range and speed. Both increase as the frequency rises. The table below provides an overview of the application areas.

To ensure that RFID systems are compatible around the world, companies need uniform standards. In merchandise management, ultra-high frequencies have become the frequency range of choice. They offer two major advantages: fast data transmission and a long read range. Trials have already shown that this frequency range works effectively. Other sectors are focusing on high frequencies (HF). These frequencies are being used in areas where the transponders are read from short ranges. The pharmaceutical industry, for instance, uses HF transponders to label medication. Other areas of applications are lift passes at ski resorts and public transportation tickets.

Technological progress

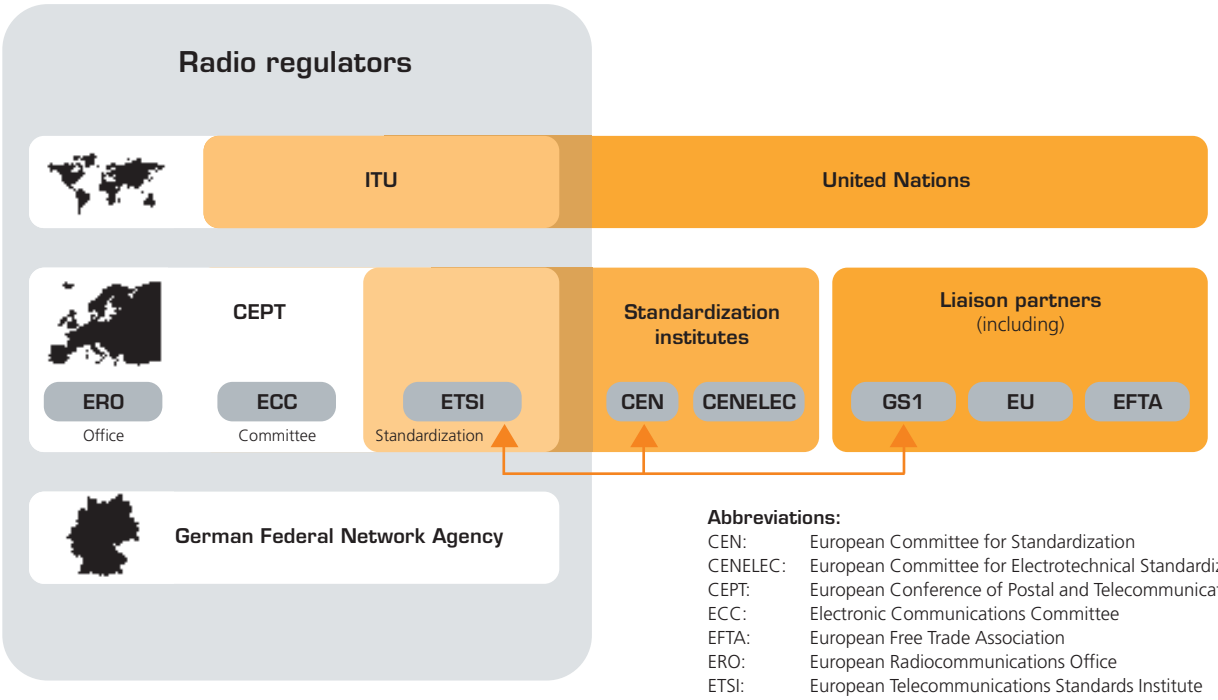
In light of the growing focus on ultra-high frequencies (UHF) in trade, retail, and the consumer goods industry, technology suppliers have quickly optimized their systems. Among other things, they have developed UHF transponders that avoid metal reflection and absorbing effects. This development shows that standardization is the engine of technological progress.

Radio regulation

Just like RFID systems, radios and cell phones transmit their signals via radio waves. To prevent disruptions, regulations define which frequency range is reserved for each application. The use of radio frequencies for identification purposes (RFID) does not represent a special area of application. RFID users can employ so-called ISM frequencies, which have been made available for **i**ndustrial, **s**cientific, and **m**edical purposes. Government agencies and supranational organizations regulate the assignment of frequencies.

The chart on page five provides an overview.

RFID frequencies	Applications (examples)	Typical ranges
LF	■ Animal identification	■ 1–1.5 meters
Low frequency	■ Production monitoring	
125–135 kHz	■ Automation	
	■ Access control	
	■ Auto engine immobilizer	■ Several centimeters
HF	■ Retail goods (individual products)	■ 1–1.5 meters
High frequency	■ Library management	■ 1–1.5 meters
13.56 MHz	■ Ticketing (public transportation, events, ski lifts)	■ 10 centimeters + security
	■ Access control	
	■ Automation	
	■ NFC – near field communications	■ 10 centimeters + security
UHF	■ Pallet identification and	■ 3–4 meters Europe, 7 meters USA
Ultra-high frequency	carton identification (trade and retail)	
860–960 MHz		
Active transponders	■ Container identification	■ Up to several hundred meters
(GHz) (with battery)	■ Production monitoring	



Abbreviations:

CEN:	European Committee for Standardization
CENELEC:	European Committee for Electrotechnical Standardization
CEPT:	European Conference of Postal and Telecommunications Administrations
ECC:	Electronic Communications Committee
EFTA:	European Free Trade Association
ERO:	European Radiocommunications Office
ETSI:	European Telecommunications Standards Institute
EU:	European Union
GS1:	Global Standards One (formerly EAN International)
ITU:	International Telecommunication Union

HUMAN AND ENVIRONMENTAL PROTECTION

Europe has specific legal regulations governing the transmission of information via so-called "electromagnetic fields." In 1998 an international commission of the World Health Organization (WHO) recommended radiation limits on electromagnetic fields. The limits have been set at a level where current scientific findings show that the application of the technology will not cause any health risks. On the basis of these recommendations, Germany developed the EN standard EN 50357. This norm defines the legally permissible levels for RFID systems.

The issue of disposal has not yet been finally resolved. Currently, RFID transponders that are part of an electric appliance must be disposed of together with the appliance as waste electrical equipment. If the chip is part of outer packaging or is attached to the product as a label, regulations allow it be treated as normal household trash. This issue is regulated by the European Union's WEEE Directive 2002/96/EC on Waste Electrical and Electronic Equipment. In the future, disposal or recycling will play an important role. The recycling of RFID transponders is possible, especially for products that are already in circulation. This includes shipment packaging and pallets. In addition, material researchers are making enormous progress in this area. Transponders produced with polymer technology will not contain metals or silicon, thus altogether eliminating disposal problems. Working with its members, EPCglobal supports research into environmental friendliness and recycling.

RFID IN AN INTERNATIONAL CONTEXT – STANDARDIZATION

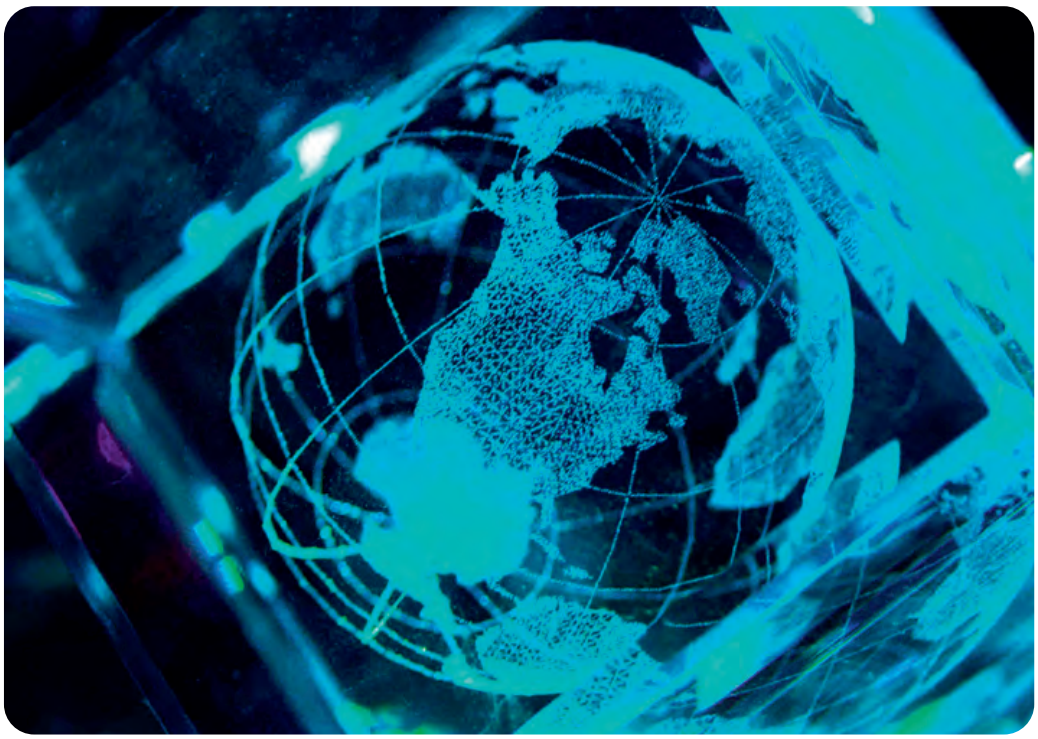
Most of today's RFID applications are closed systems – such as access control to buildings, ski lifts, and stadiums, or engine immobilizers incorporated into car keys. In closed systems, the technology can be designed to serve the exact need – without any consideration of factors outside the system. The drawback of closed systems is that the use of the RFID solution is restricted to the individual system. The system operator alone must cover the costs of development, introduction, and operation.

With an open RFID system, all participants can communicate with one another through the system. A typical example is the supply chain in which pre-suppliers, producers, logistics service suppliers, and retailers exchange merchandise and data. In open systems, several actors profit from the RFID technology. Thus, the costs can be shared proportionally. The crucial operating factor of open RFID systems is the general readability of the RFID transponders. To achieve this, general standards must be created and applied.

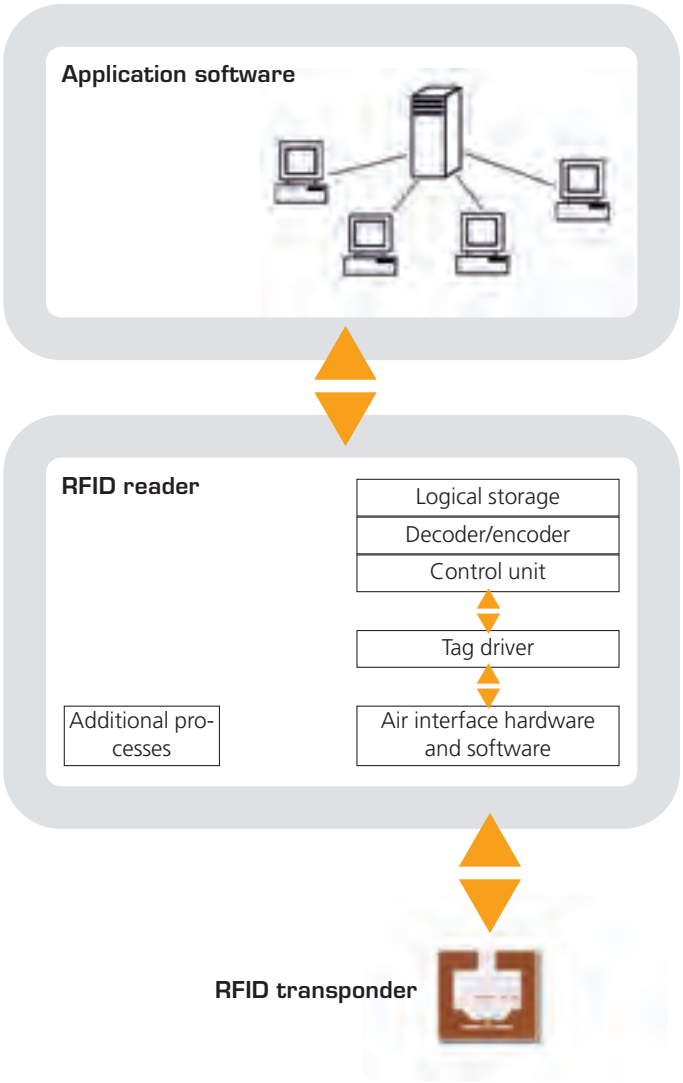
Cross-application and cross-sector standards from EPCglobal and ISO

EPCglobal and the International Organization for Standardization (ISO) develop technological, application and cross-sector norms and standards. EPCglobal was set up in 2003 by GS1 and GS1US. In Germany, GS1 Germany is the contractual partner for companies and institutions that are involved in the development of standards as members of EPCglobal. The organization's goal is to develop business and technical standards for the EPC network. The EPC network is a special system architecture that enables users to access the electronic product code (EPC). The EPC is a set of numbers stored on the RFID chip and uniquely identifies products.

The ISO has also developed standards for RFID applications and incorporated pre-existing norms into its set of regulations. Standards like ISO 14443 und ISO 15693 governing communications between the transponder and reader (air interface) are widely used.



Standardization areas



Cross-application standards apply to these areas, among others:

- **Data Standard**
The data standard defines which data can be stored on an RFID transponder and in which format.

- **Air interface**
The air interface determines the physical conditions – such as the frequency range – under which data can be transmitted back and forth between the transponder and the reader.

- **Data protocol**
The data protocol establishes the sequence for the transmission of certain information

- **Network standards**
Uniform standards are needed in order to store data in a network to which various persons and organizations have access.

- **Review process**
Uniform review processes enable the individual components of an RFID system to be tested in an effort to determine whether they work in concert.

- **Application recommendation**
Standardization organizations issue concrete recommendations governing the use of RFID technology, the installation of RFID readers and antennas, the applications of RFID transponders, and recyclability.

Sector-specific standards

Organizations such as the International Air Transport Association (IATA) and the German Association of the Automobile Industry (VDA) are currently working on sector-specific standards. The extent to which these will be linked to ISO or EPCglobal standards has not yet been determined.

WHERE ARE WE TODAY? THE RESEARCH NEEDS OF RFID

The most groundbreaking research into RFID technology was conducted in the 1990s by the Auto-ID Center at the Massachusetts Institute of Technology (MIT). The institute remains the research leader in this area today. The standardization organization EPCglobal grew out of the Auto-ID Center.

Germany also has various institutes that are playing a leading role in the continued development of RFID technology. These include various institutes of the Fraunhofer Gesellschaft, including the Fraunhofer Institute for Material Flow and Logistics. In Switzerland, the M-Lab of the universities of St. Gallen and Zurich has also won worldwide recognition. It is part of the international association of Auto-ID Labs.

The METRO Group and the standardization organization GS1 Germany jointly set up a test lab in 2005 and this lab became the first center in Europe to receive the title of European EPC Competence Center (EECC) from EPCglobal. It offers users, suppliers, and service providers the facilities needed to explore and develop RFID technology.

Research fields

Scientists are currently primarily focusing their research on three areas: the improvement of current technological standards, the development of new approaches, and the social impact of RFID technology.

- **Label**

Only about 50 percent of the costs for today's RFID transponders are attributed to the silicon chip. The remaining costs are created by the carrier material, the antenna, and its connection to the chip. Researchers are working to lower the production costs of the individual components. In addition, these components must be flexible, environmentally friendly, and multifunctional. In order to integrate the transponder into a product, it should be as easy to combine with other materials as possible.

- **Chip design**

To reduce the size of the transponder, the chips, sensors, radio components, and power source must be blended into a single unit.

- **Power source**

The power source is a major challenge: The RFID transponder should be as small as possible and the battery generally cannot be recharged. Researchers are exploring film batteries, energy-saving algorithms (especially for cryptographic processes), energy harvesting, and energy-conservation management.

- **Radio transmission**

New antenna designs can improve the read range and read rate. "Printed" antennas can be integrated into objects more easily. In the long term the assigned frequencies must be used more efficiently to manage increased radio traffic.

- **Sensors**

In the future users may find new applications by linking sensor technology and RFID. Nevertheless, extensive research must still

be conducted in this area. Integration in the chip, power-conserving and event-controlled sensors, and the diminution of the sensors to sub-molecular size would represent significant steps in the integration of RFID technology.

IT architecture

IT architectures must be changed to improve harmonization with RFID systems and to exploit the benefits of modern real-time systems. Decentralized, self-organizing computer systems are needed. Within them, the intelligent object has a higher level of autonomy.

Cryptography

To ensure data protection, coding technology must be adapted to the needs of RFID technology: The key requirements are shorter computing times and reduced storage space.

Polymer technology

A fundamental factor in the future of RFID is polymer research. The goal of this research is to end the production of transponders from silicon chips and metal antennas and to manufacture them solely from organic polymer structures. Known polymer structures are PET, PVC, and nylon. In 2005, employees of the German company PolyIC succeeded for the first time in producing an operational polymer 13.56 MHz transponder. Still, many hurdles must be cleared before it is ready for mass production. The radio performance, for instance, remains weak. Researchers project that it will be possible to mass produce polymer-based RFID transponders in about 10 years. It is hoped that polymer chips will lead to lower-priced transponders. The materials are inexpensive and the printing process simplifies the manufacturing process. Because the RFID chip is imprinted, it is also easier to integrate the RFID transponders into products and packaging. One other strength of the polymer chip is its high level of environmental friendliness.

Bistable displays

Displays are needed to visually place the data of the RFID chip, including the serial number, on the transponder. Conventional LCD displays need a constant supply of power. Bistable displays need power only to change the display. As a result, they have huge potential in regard to RFID technology.

Socio-economic research

RFID will have an impact on the social and economic environment. Research into these socio-economic factors will be particularly important in the effort to better recognize this impact and to react to it. This is the only way that RFID will be successfully introduced on a broad basis.

RFID AND CONSUMER PROTECTION

The creation of value is not the sole purpose of radio frequency identification. In terms of consumer protection, the technology also has promising potential in such areas as the pharmaceutical industry. Experts estimate that every 10th medication is counterfeit. Siemens has developed RFID transponders that can be easily integrated into medication packaging. As a result, the medication is clearly labeled and patients can be protected from potentially life-threatening fake medicines. The technology can also prevent financial and business losses that companies suffer as a result of counterfeit products. In addition, RFID simplifies returns management and improves processes along the entire logistics chain. RFID-labeled products ease pharmacists' administrative tasks.

RFID can also improve consumer protection in the food industry. Philips, for instance, has produced RFID transponders that animal breeders use to tag cattle. With these transponders, exact information about each animal, including lineage, pedigree, breeding, feed, and veterinary care, can be tracked – from birth to the slaughterhouse. In addition to this data, information about processing and the supply chain can be included on the RFID transponder that is part of the meat packaging. Transponders with temperature sensors enable the cold chain to be seamlessly monitored. RFID also guarantees company-wide traceability. Should a quality problem arise, recall announcements can be precisely and quickly issued. This benefit applies not only to fresh products such as meat, but also to cars and other technical equipment.

STRENGTHS AND OPPORTUNITIES

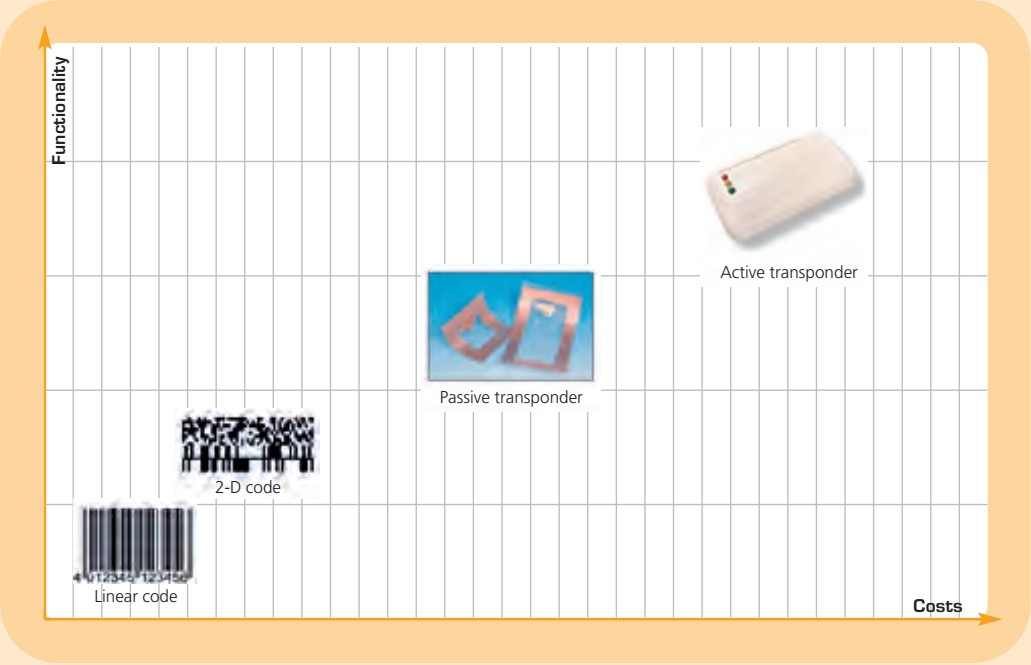
Today, industry, trade, and retail are committed to RFID as a technology of the future because it optimizes their processes, lowers process costs, and increases product safety – for consumers as well. Currently, however, the high unit cost of the transponders stands in the way of large-scale use. Sector experts expect that the price per chip will be as low as one cent by 2015. Nonetheless, one should not assume that RFID transponders will replace barcodes in trade, retail, and logistics overnight. The more probable scenario is that both technologies will exist parallel to each other for a long period of time. In a comparison of the two, though, RFID technology definitely has some clear advantages over barcodes:

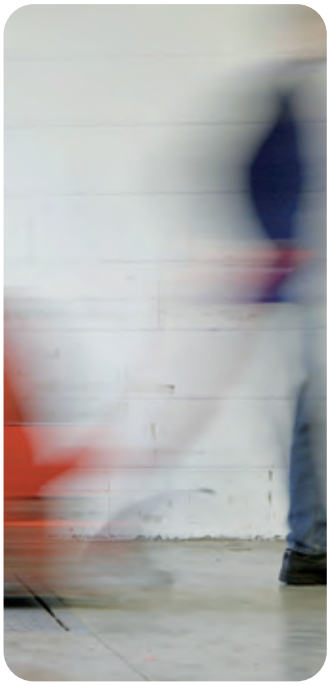
- Data collection without physical or line of sight contact in real time
- Multi-tag reading
- Expanded storage capacity for data
- Resistance to dirt and other potential damage
- Data-storage and data-alteration capacity

The use of RFID technology creates opportunities in all realms of life – for business, science, government, and leisure-time activities. RFID can

- Optimize processes,
- Facilitate traceability,
- Guarantee authenticity,
- Improve product safety,
- Boost the efficiency of warehouse management,
- Simplify access control.

Furthermore, RFID technology fosters the development of autonomous systems that act and think for themselves. For example, if shelves in a warehouse are equipped with RFID readers, they will "know" when supplies are running low. The computer could automatically place a re-supply order when necessary.





THE SIGNIFICANCE OF RFID FOR MID-SIZED BUSINESSES

The market for RFID is growing rapidly. Experts estimate that global spending on this technology will reach €22 billion by 2010. This compares with €1.5 billion in 2004. Within the same timeframe, the RFID market in the EU-15 countries is likely to climb from €0.4 billion to €4 billion. The trendsetters in the introduction of radio frequency identification are trade and retail companies, including Wal-Mart in the United States and METRO Group in Europe. Studies have shown that the technology has a huge potential in the area of retail logistics. Today, the sales brands of Metro Cash & Carry and Real, and the distribution warehouses of METRO Group are already saving a total of €8.5 million in Germany every year. Thanks to RFID, Wal-Mart was able to cut the number of sold-out products by 16 percent. With the help of the technology, stock shortages can be eliminated three times faster than before.

At the moment, there are no reliable figures for small and mid-sized companies. But examples from various branches clearly show that RFID can significantly improve processes in these businesses as well. Carl Schnicks GmbH & Co. KG – a producer of plastic window and door profiles – used RFID to improve warehouse organization and transparency and to simplify processes. Another example is the waste management companies in the western German city of Warendorf. Among other things, they regularly inspect the sewage network. With radio frequency identification, they have optimized maintenance work and accelerated work processes.

These examples show that RFID is more than a technology with major potential for large industrial and retailing companies. For this reason, small and mid-sized companies should avoid being left behind. Keeping up with the technology is the only way for them to secure the future competitive advantages offered by RFID.

The Informationsforum RFID has compiled a guide for small and mid-sized companies that is designed to help them. The publication provides 10 case studies that describe how small and mid-sized companies successfully introduced RFID technology. The guide also provides a quick check-list of the benefits of RFID, offers tips on introducing projects, and lists important points of contact that can provide further advice and decision-making assistance on the introduction of RFID. The aim is to make small and mid-sized companies aware of the technology's potential.

The guide (in German) can be downloaded at www.info-rfid.de.

RFID AND PRIVACY

Technical innovations help make people's lives easier, more efficient, and safer. Radio frequency identification does so, too. With this technology, objects can be linked to data in a computer system. Information – about products, for instance – can be collected automatically, opening up a wide spectrum of applications.

Critics worry that, as the use of RFID spreads, data will be collected in a surreptitious way and without the permission of the affected parties. For this reason, data protection and the right to informational self-determination are important issues in regard to the technology. However, in most applications, including logistics and production management, no personal data is collected, processed, or used.

The consumer decides

There are areas of application for RFID where personal data is processed. These areas include access control and membership cards to health clubs. In a – future – application of RFID in retailing, personal data will be collected only when the consumer uses a customer card. The German Data Protection Act applies anytime personal data is stored. People who collect, process, or use personal data are required to inform the person about the procedure and receive his or her permission. Even after permission has been granted, the consumer can revoke it at any time. These current data-protection regulations provide adequate assurance that RFID will be used in an unobjectionable way.

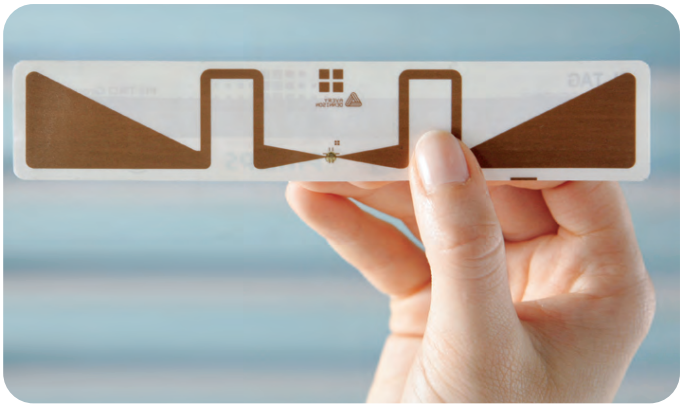
Transparency in the use of RFID

To exercise their rights, consumers must be informed about RFID's potential uses and means of operation. Transparency is an important requirement to achieve this goal. One example of open communication is the EPCglobal guidelines: Here, the members of the international standardization organization EPCglobal have made a voluntary pledge regarding the use of RFID. Among other things, this commitment requires that products and packaging containing transponders will bear the EPCglobal logo. This will serve as a signal about the use of RFID. In addition, the participating companies will inform consumers about the way that the technology operates and where it will be used. Furthermore, they will make it possible for consumers to be able to remove the transponders, turn them off, or make them non-operational from purchased products. As with conventional barcode technology, EPC-specific data will be collected, compiled, stored, maintained, and protected in accordance with current legal regulations. EPCglobal will regularly supplement and modify the regulations in order to keep up with the further development of RFID technology.

Working together, the political, academic, and business communities should conduct a regular dialogue about the privacy aspects of RFID. After all, companies and consumers profit equally from the use of the technology. In so doing, it is up to the individual to decide which of the many possibilities he or she would like to use and which ones he or she would like to turn down.

As a contribution to the public debate about the issue of data protection, the Informationsforum RFID asked Prof. Dr. Bernd Holznagel, University of Münster, to conduct a study on the legal aspects of radio frequency identification. The study examines the legal foundation of data protection and presents ways of responsibly using RFID technology.

The study (in German) can be downloaded at www.info-rfid.de



AN OVERVIEW OF RFID APPLICATIONS

The commercial forerunners of RFID technology entered the market in the 1960s. But it was not until recently that research and development helped trigger its breakthrough. Since then, RFID has become accepted into many sectors.

Logistics

RFID systems offer many potential uses in logistics and transportation, including the automotive industry, and in the transport processes used in the management of reusable transport units. RFID is also being employed in airports. In Shanghai an RFID transponder is applied to each piece of luggage, enabling it to be loaded much faster and more reliably than with conventional barcode technology. And if a piece of luggage happens to get lost, airport personnel can find it more easily.

Production managementg

RFID solutions have been introduced in several areas of car-manufacturing. In the production of the BMW 3 series, an RFID system made by Siemens is attached to the car body. This system enables the bodies to be tracked at any time and contains all information relevant to the production of the vehicle. Volkswagen also uses RFID technology for such jobs as production-stage documentation, management of car body flow in production, and process optimization. A receptacle management system supported by RFID helps improve organization and the reliability of just-in-time production. The Flensburger brewery uses RFID transponders on its beer kegs. The transponders improve container management and conserve energy and water. With the aid of the technology, the washer unit recognizes the type of beer that the keg contained and can automatically adjust the intensity of the cleaning process.

Health care

In health care, RFID systems have been used to label blood plasma, specimens, and other medical products. A medical center in Amsterdam, for instance, places RFID transponders containing temperature sensors on units of blood. As a result, the cold chain is automatically monitored.

Pharmaceutical industry

The pharmaceutical industry uses RFID to clearly label products, protecting patients from life-threatening counterfeit medications and significantly reducing cases of misuse and misapplication. The pharmaceutical company GlaxoSmithKline, for example, places passive RFID transponders on all bottles of the HIV medication Trizivir.

Trade and retail

Up until now, trade and retail companies have employed RFID primarily in logistics and inventory management. RFID creates transparency in logistical processes and enables merchandise management processes to be controlled more efficiently. METRO Group is one of the pioneers in the introduction of RFID technology. In the company's sales centers, workers no longer have to manually record pallets once RFID transponders are attached to them. Readers set up at the warehouse entrances and exits automatically record the deliveries within seconds. As a result, the merchandise and information flow can run parallel.

Public institutions

Public institutions also profit from RFID solutions. Transponder technology, for instance, simplifies the check-out of material from libraries. All media that can be lent contains transponders, a development that considerably accelerates the check-out procedure. In addition, the technology improves theft protection. The Volkswagen Library at the Technical University of Berlin and the Berlin University of the Arts, the city libraries of Munich, Stuttgart, and Siegburg, the main library in Vienna, and the library at the Vatican are among the present users of RFID technology.

RFID technology also offers many benefits in traditional areas of public administration. For instance, transponders are placed on all documents in the regional court in Detmold. With the help of a PC, the documents are easier to locate. Time-consuming searches and lost documents have become a thing of the past.

Maintenance and repair management

RFID systems enable the optimization of maintenance management and repair processes and quality improvement. In the Airbus A380 approximately 10,000 RFID transponders will perform routine tasks. During maintenance, workers can quickly identify important components. Each part has its own maintenance history.

Forestry

Thanks to RFID, wood harvesting in German forests is becoming increasingly more efficient. After a tree is cut, an RFID transponder is placed on the trunk, optimizing the information and process chain. As a result, the Cambium-Forstbetriebe, which manages parts of the Odenwald forest just south of Frankfurt, has been able to streamline registration and considerably lower the waste rate.

As to tree care in major cities, RFID transponders help mark the trees. Nail-like transponders are hammered into the trunks, enabling the trees to be clearly identified with a reader. Thus, data about the tree's maintenance and condition can be quickly and simply documented.

Public transportation

RFID provides users of public transportation with new comfort and convenience. In 2003, for instance, the Rhein-Ruhr Transportation Association replaced all paper monthly tickets with chip cards equipped with RFID technology. Now, passengers no longer have to obtain tickets each month. And if the ticket is lost, the customer can receive a replacement smoothly and automatically.

Animal husbandry

Identification systems have been used in electronically managed animal husbandry for more than 20 years. The Spanish association of cattle breeders (FEVEX) urges its members to place RFID transponders on their cattle. Using a database, the pedigree of the animal and veterinary information can be clearly tracked. Livestock owners are not the only ones who can profit from RFID. Transponders can help lost cats and dogs be returned to their owners, too.

Leisure time

Access-control systems without physical contact are already widely used in the leisure-time industry. In the Neptunbad in Cologne, for example, identification cards with RFID transponders ensure that visitor admission is quick, safe, and comfortable. Using a smart key, visitors can make cashless payments and open their lockers. If the smart key is lost, the visitor can have it blocked and receive a new one.

RFID is also used at marathons. Runners tie a transponder wrapped in yellow plastic to their shoes. As a result, each runner can be clearly identified, the mass start remains fair, and the finishing times can be recorded automatically. Measuring points set up at various parts of the race route enable runners to check their split times and prevent people from taking illegal shortcuts.

Further examples of applications can be found on the website of the Informationsforum RFID: www.info-rfid.de

GLOSSARY

Active transponder
RFID transponders with their own battery-generated power source are called active transponders. Some transponders have batteries that can be changed and others have batteries that are contained in an enclosed unit. The latter are also known as modular active transponders.
See "Passive transponder."

Agile Reader
A term for readers that can operate on several frequencies.
See "Reader."

Anticollision
If several transponders pick up a signal from one reader, they will respond at the same time, possibly leading to a collision of data during reception. To prevent this from happening anti-collision processes are used. As a result of these special processes, the transponders are activated individually.

Backend
The section of the RFID system that handles the actual administration of the data. Examples of the tasks performed in the backend include matching the corresponding data with the transponder's number or the administration of the reaction that follows the reading of the transponder.

Backscatter
A means of communication between readers and passive transponders. The transponder reflects back the waves of the reader and modulates its information into these reflected waves.

Beacon
Term for active transponders that "wake up" at defined intervals and transmit information.

EAN
International article number (formerly European article number). It serves as the product identification reference for trade articles and consists of a set of numbers (13 or 8 digits) that is administered internationally. With its help, each product can be allocated to a product group.

Electronic Article Surveillance (EAS)
Electronic article security device for article security and theft prevention. EAS uses the so-called 1-bit transponder. The transponders or labels supply only one type of information: "transponder available" or "transponder not available."

Electronic Product Code (EPC)
The EPC data standard promotes the clear identification of products and product types through the assignment of serial numbers. It incorporates the EAN and the Serial Shipping Container Code.

Far and near fields
An antenna is surrounded by a magnetic field. This field is constantly converted into an electromagnetic field. At a certain point the electromagnetic field begins to break free of the antenna and to propagate through space as an electromagnetic wave. The term used to describe the area beyond this point – calculated as lambda/2pi – is a far field. Inductive coupling between the reader and transponder is possible up to the distance of lambda/2pi. This area is called the near field.

Faraday cage
The physicist Michael Faraday discovered that the interior of an electric conductor is always a zero field. A container made of metal acts as a shield. As a result, the reading of RFID transponders in metal containers is not possible.

Flat antenna
A flat, conducting antenna, generally made of a metal plate or foil.

Flash
Term for a non-volatile, reprogrammable memory.

Frequency
The number of cycles that a periodic signal transmits within a certain unit of time.

Middleware
The segment of the RFID systems that connects the reader to the backend.
See "Reader" and "Backend."

Multi-tag reading
The nearly simultaneous reading of several transponders by a reader. Because of the phenomenon of collision, the transponders cannot be read at precisely the same time. Rather, they are read quickly one after the other.
See also "Anti-collision."

Near field communication (NFC)
RFID systems that operate in the near field are called NFC systems. The radius of the near field is determined by the frequency or wavelength in use.

Nominal range
The read range at which a transponder can be read reliably.

Passive transponder
Unlike active transponders, passive transponders do not have their own power supply. Their power comes from external sources. Typically, they receive this power from radio waves emitted from the reader.
See "Active transponder."

Read
The decoding, extraction, and display of data content that is transmitted in addition to the bits from the transponder that are designated for format definition, control, and error management.

Reader
An antenna that emits signals to transponders and receives their data. Most readers are also writers. Using radio signals, they place data on writeable transponders.

Read rate
The speed at which data from a transponder can be read, expressed in bits or bytes per second.

RFID (radio frequency identification)
RFID is a technology for the non-contact transmission of data through the physical basis of electromagnetic alternating field radio waves. The heart of RFID technology is an RFID transponder. This tiny computer chip with an antenna is attached to the object and contains a number code, such as the Electronic Product Code (see EPC). The code is read by a reader.

RFID tag See "Tag."

RFID transponder See "Transponder."

Scanner
An electrical device that turns optical information into electric signals and transmits these signals to a computer for decoding. Antennas, transmitters (or exciters), and receivers are integrated components of a scanner.

Sensor
A device that responds to a physical stimulus and produces an electronic signal. See "Scanner."

Tag
Tag is a popular term for RFID transponder. See "Transponder," "Active transponder" and "Passive transponder."

Transponder
Transponder is a word created from the terms "transmitter" and "responder" (other popular terms are "RFID labels"or"tags"). See "Active transponder" and "passive transponder."

2-D barcode
Unlike conventional barcodes, the data is not printed in simple bar sequences. Rather, it is stored within a field in a two-dimensional pattern. This significantly increases storage space. But it also complicates the reading process. There is no uniform standard for 2-D barcodes.

Write rate
The rate at which data is transmitted to a transponder, written into the transponder's memory, and verified as being correct. The rate is expressed as the average number of bits or bytes that are transmitted per second until the transmission is completed.

INFORMATIONSFORUM RFID

The Informationsforum RFID e. V. was established in April 2005 with the aim of making the public increasingly aware of the future and innovation potential of radio frequency identification (RFID) and promoting the use of this promising technology in an open dialogue.

Disseminating information

The mission of the Informationsforum RFID is to explain RFID to the public, to provide comprehensive information to political decision-makers, media representatives and consumers, and to describe the variety of uses offered by the technology. For this purpose, the forum disseminates factual information with which people can objectively evaluate the technology. In addition, the association contributes to the effort to bundle and clarify open questions – on issues such as standards, frequencies, the compatibility of various systems, and legal regulations.

Promoting dialogue

The Informationsforum RFID views itself as a platform for dialogue. It offers representatives from politics, business, academia, and media, as well as interested consumers an opportunity to exchange views about the technology. The information forum is a skilled intermediary among technical development, technical information, and political evaluation.

The impact for Germany as a technology site

One of the chief responsibilities of the forum is to underscore the potential of RFID for the future of Germany as a technology site. The representatives of the forum actively contribute their knowledge to the social debate. Using concrete application examples, the Informationsforum RFID communicates an understanding for the technology and its benefits.

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IMPRINT

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Printing
Druckerei Hölters

Photo credit
GS1 Germany, Informationsforum RFID,
METRO AG, Photocase

Publication date
Juni 2006

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