



**ERPS**  
**European Center for Research in Purchasing and Supply**  
**Vienna**

**RFID – The New Technology**  
**Affecting Logistics and the Supply Chain**

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## **ERPS – European Center for Research in Purchasing and Supply**

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# **RFID – The New Technology Affecting Logistics and the Supply Chain**

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# **1. RFID**

## **System, Function, Standards**

RFID – short for Radio Frequency Identification – is a technology which allows the unmistakable, contactless identification of objects, using radio frequency without line of sight being required. This means humans, animals and inanimate objects (e.g. goods) can be identified and allocated in real time.

Each RFID-system consists of two components: a transponder which includes a chip with antenna (tag/label) affixed to the object to be identified, and a reading and writing device. The transmitted radio beam from the antenna allows the immediate identification of the geographical location of the object (transponder technology).

Transponders which comply with ISO-standards carry a microchip to store the reading/writing function; they do not need any maintenance, have a long life, and can be reused even after 100,000 rewriting operations.

All RFID transponders have a serial number (EPC number) which is globally unique and recognized world-wide. The EPC (Electronic Product Code) system has been established by 103 states as a global network with its very own numbering scheme. The EPC included in the tag does not only allow the identification of article numbers but also of individual units, serving a multitude of purposes, e.g. as record of origin.

Enabled by radio frequency – via electromagnetic fields – reading operations do not require line of sight. This is a major difference to conventional barcoding systems which utilize chip cards with line of sight.

Transponders are available in a variety of types and shapes today, e.g. as discs, ISO-cards, smart labels, glass tags etc. They are extremely flexible for adjustment to specific company requirements and special object properties.

The RFID systems currently available differ in their key characteristics such as operating range, capabilities, frequencies, power supply, data volume, memory capacity, programmability, type of data carrier, data transfer and, as a matter of consequence, cost.

The selection criteria for a company depend on the business strategy and special requirements: reading/writing range, official regulations, bulk capacity, memory

capacity, standardisation, comparability, power supply for RFID information technology, data integration, structure, and cost.

The presently available operating range of 1 cm to 1 m as well as power supply via battery (active transponder) and without battery (passive transponder) determine the frequency ranges and costs. Information is transported via *data on tag*. Data-on-Tag include content and history of e.g., a container, and can be accessed any time. Data on Tag is already being used in the car manufacturing industry to support Kanban processes. Another example from the industry is in the retail of perishable goods where specially integrated thermosensors ensure a seamless and documented monitoring of some goods' storage temperature.

### **Standards**

The global utilization of RFID technology calls for global standards, applicable to all companies. The International Organisation for Standardization (ISO) has already established a number of standards: Basic Standard ISO 18000 – 6C, furthermore ISO 15961, 15962, 15963 for transponders and air interface as well as frequency, items, and Smart Cards, and other relevant standards.

Nevertheless there is still a lot of work to be done in this relatively new field of technology. The organisation EPC Global has developed a Tag Data Standard (TDS), establishing the following six EPC classes:

- Class 0        read only transponder
- Class 1        write once, read multiple transponder
- Class 2        read and write transponder
- Class 3 – 5    multiple read and write transponder with its  
                  own power source

The orientation of the identification system is in accordance with the global standard EAN. Ongoing standardization efforts will ensure the compatibility of different manufacturers' systems world-wide and will also drive cost reductions. These standards will also be an essential basis for any company planning to introduce RFID technology.

## **2. Areas of Application – Possibilities and Examples**

The unmistakable and real-time identification of an object by means of RFID opens up a wealth of areas of application and combinations which are far from having been fully explored yet. RFID can be used in any context where a large number of humans, animals or goods need to be clearly identified - RFID has actually been used for ski passes in ski resorts for more than 20 years now!

RFID is already successfully used in the following areas of application:

Identification of humans and animals, anti-theft devices (e.g. immobilisation of cars), purchasing, logistics, inventory management and controlling, stock keeping technologies, authentication, drug management, incoming and outgoing goods operations, tracking & tracing, supply management, goods retrieval, logistics planning, IT planning, engineering, library management, container management, temperature control, luggage tagging, spare parts management, public health service (patient management, hospitals, medical equipment), toll collection, event management, asset management and counterfeit protection. In addition, there are a variety of applications in the supply chain and in customer relationship management.

All these examples of RFID applications benefit from the storage and off-line transmission of comprehensive material data.

### **Examples:**

#### a) Passports

The biometric passports requested by the US authorities today are fitted with a digital photo and two fingerprints. The officers at immigration/passport control will be equipped with handheld readers which are small, compact portable RFID reading/writing devices for full active authentication.

#### b) Social security cards

Social security cards fitted with RFID chips could be used to store numerous personal data.

c) Animal/livestock identification

Within the European Union there are regulations concerning the identification of pets such as dogs and cats when crossing inner-European borders. By injecting miniature identification tags (approx. the size of rice grains ), such requirements can be fully complied with. The tag includes a 10-digit alpha-numeric code for the clear identification of the animal and also provides all requested data about inoculations and such. RFID can also be used to put a stop to illegal imports of livestock and pets into the European Union.

d) Prescription drugs

Specifications need to be traced for each prescription drug. RFID ensures that there is tamper-proof data concerning information such as authentication, track and trace throughout the supply chain, date and time of manufacture, sell-by dates, storage temperature record, and other relevant details. Both the USA and the European Union are planning to introduce RFID as mandatory for prescription drugs, covering all stations of a drug from its production to the final consumer. Such regulations also aim to protect medical patients for faked and expired products.

e) Produce industry (food and beverages)

The Italian food producer Virgilio implants RFID tags under the skin of each of their wheels of cheese to ensure that their customers receive high quality produce. The tags carry information about the place and time of production, fat content, quality and sell-by date.

f) Access control

The World Youth Day 2005 was held in Cologne, Germany. 800,000 young people and 1,500 operating staff attended the mass held by Pope Benedikt XVI. The organisation was hugely successful, enabled by RFID identification bracelets that all attendants wore.

Other examples for the use of such identification bracelets can be seen in tourism. More and more all-inclusive hotel resorts use RFID to control guest access to facilities and events.

g) Patient identification

Patients in hospitals can be given RFID bracelets, not only for identification but also to store drug information and patient history. RFID is also being used for the management and maintenance of medical equipment and machinery.

h) An innovative application of RFID technology

At the official opening and inauguration ceremony of the new football stadium in Bern/Switzerland the entry tickets for invited guests were integrated in a special edition Swatch watch fitted with a 25 kHz RFID chip.

i) Car immobilization

Car keys fitted with a special RFID chip will – due to their uniqueness – only allow authorized persons access and operation of the respective car.

j) Airline luggage management

The International Airlines and Airports Association (IATA) is about to introduce a uniform standard for the worldwide use of RFID labels for luggage tagging. This move aims to reduce the volume of lost luggage and to downsize administration. IATA expects savings of up to USD 750 million per year from using RFID technology in luggage handling.

k) Traffic control / toll system

A variety of toll systems implemented in Europe today are using RFID technology. These toll systems are suitable for further development and expansion.

l) Archiving and Maintenance / Aviation

The company Airbus complies with official documentation and maintenance requirements by means of a special RFID-enabled archive management. RFID labels allow a seamless recording of the complete preventive and corrective maintenance and servicing of planes through the entire lifetime of the planes, including spare parts, tools and controls.

A real-time off-line status report is available at any time, safeguarding the optimum maintenance of all Airbus planes.

m) Component Management

Car and engine manufacturers have been using RFID technology to coordinate their component purchasing and ensure the traceability of their engines. This enables them to assemble a variety of car models simultaneously and just-in-time, and to electronically store all relevant details such as wear&tear information and warranty times.

n) Library and document management

The Vatican library, one of the largest in the world, uses RFID for entering, searching, sorting and for lending & returning books. They also use the same system for the administration and control of their vast inventories.

o) Logistics

Large logistics companies utilize RFID in both their own and their customers' packaging, transport and inventory management, especially in the container management. This ensures real-time identification, traceability and authenticity as well as other important storage information such as temperature records (documenting the correct cooling of goods).

p) Retail and trade

RFID has established itself in a variety of companies and across industries. RFID pioneers such as Metro, Ahold, Tesco, Carrefour, Marks & Spencer, Wal Mart, Procter & Gamble, Hewlett Packard, Gillette and Siemens have effectively integrated their suppliers into their RFID systems and have thus massively changed the makeup of their supply chains.

The Metro group, e.g., and its suppliers below have agreed on the mandatory use of RFID: Beiersdorf, Colgate, Palmolive, Henkel, L'Oreal, Unilever, Melitta and Snackworld. The aim is to shorten throughput times, improve continuous goods monitoring and goods availability, and to optimize the overall supply coordination. There are similar systems currently being considered by the German textiles industry.

### 3. Advantages/Cost Comparison: Barcoding versus RFID

The examples provided herein show the multitude of possibilities to apply RFID. The real-time data captured for the identification and localization of humans, animals/livestock, containers and containerized items, systems and individual objects allow a fast reaction to volatile market developments (e.g. through the adaptive network of the supply chain).

As a result, the specific **advantages** to be gained from RFID depend on the concrete area of application:

- better planning
- higher transparency
- better controlling
- higher security (anti-theft)
- better protection against counterfeit / tamper-proof data
- improved inventory management  
(faster stocktaking, lower stock and working capital)
- better refilling procedures
- fewer „out-of-stock“ situations
- systematic call-back actions possible
- fewer obsolete items (sell-by dates)
- lower product variety
- more efficient temperature control
- lower administration cost
- RFID-orientated supply chain possible

Such advantages increase efficiency levels in productivity, logistics, trading, services as well as the public sector. Consumers benefit from guaranteed authentication, a documented cool-storage chain (for drugs, food, produce) and safeguarded quality. They are also better protected against possible diseases and infections (animal, meat-based). The EU directive EU VO 178/2002 accounts for such risks by requesting tamper-proof, seamless information about the source and content of a product and its use. It also demands simplified procedures for the return or exchange

of goods being called back by the manufacturer. RFID has an answer to all these points.

Companies benefit from RFID driven advantages and cost reductions as a result of fewer customer complaints, fewer invoicing discrepancies, fewer non-conformities in quality and delivery, a higher inventory turnover rate, reduced stock levels, fewer cases of counterfeit and theft, shorter delivery times and higher accuracy. Insurance and logistics costs can be reduced, too.

### **Evaluation of advantages**

In the pharmaceutical sector, it is anticipated that RFID will ensure 10% higher sales as approx. 10% of all drugs in the market are counterfeit.

Invoicing discrepancies between buyer and seller are everyday occurrences in trade and retail. Manual operations to capture stock data and conformity of delivered goods are frequent sources of error and can create discrepancies between invoices received and payments effected. There are estimates indicating that manufacturers lose 4 - 9 % of their annual sales because of such billing and payment errors.

RFID can provide answers to these problems based on the transmission of EPC data and the controlling of the entire logistics chain. Scanning RFID labels/tags prior to loading a truck allows manufacturers to check if the goods and volume to be dispatched actually correspond to the attached delivery note and the ordered quantity. The distribution centre can create an automatic and electronic receipt which can also be used for onward shipping. This reduces the risk of conflicting data between ordering, shipping and billing.

### **Non-conform deliveries**

Seamless monitoring and tracking ensures that consignments which have erroneously been misdirected can be redirected in due time. The shipping department is able to adjust their planning accordingly at short notice. The rate of non-conform deliveries is currently held to account for up to 10% of cost.

### Reduction of stock levels

RFID allows simplified data capture, accessibility, restocking as well as on-time sales and dispatch of goods with sell-by date. Estimates say that there is a savings potential of up to 6% in this field, depending on the industry.

### Logistics and transportation

A large share of global transportation is containerized. RFID-fitted chips ensure a closed circuit of monitoring, planning and documenting container movements and locations. Container repairs and cleaning can be planned better and ensuring rental efficiency and pricing.

When implementing an RFID system for cargo (raw materials, parts, components, finished products, bulk material, conventional mail), such a system should encompass the packaging side (bundles, pallets, containers, boxes, crates, etc) as well as the transport and cargo handling media used (robots, lorries, forklifts, cranes, vessels). Such an approach will allow a strong RFID integration in the company. It can help reduce stock levels, prevent stock-outs, facilitate the tracking of individual cargo, and reduce overall cost.

### **Cost**

The cost of using RFID technology within a company and within its supply chain should be carefully calculated and weighed against the required capital expenditure, changeover and consultancy cost. Technological options (expansion of the existing IT-Information system) need to be secured and assessed. Cost and criteria of RFID systems should be compared with available barcoding systems.

<b>RFID</b>	<b>Barcode</b>
Information not visible	Information visible
Contactless, tamper-proof identification not requiring line of sight	Conventional identification requiring line of sight, tampering is possible
Repeat writing	One-time writing only
Resistent against external influences (weather), limited dependency on type of material (e.g. metal, fluids, liquids)	Visibility can be limited (e.g. due to dirt, weather wear), no dependency on materials
Simultaneous capture of many products – individual solutions possible	Simultaneous capture of many products not possible in many applications
Bulk possible	Bulk not possible

<b>RFID</b>	<b>Barcode</b>
High memory volume, variable data storage, temperatur control systems (cool-storage chain)	Low memory volume, temperatur control difficult
Long life (10 years)	Short life
Data can only be read by means of spezial devices (reading units)	Data capture simple and also possible without devices/tools
Can be integrated in company´s IT system	Limited possibility of integration in company´s IT system
Cross-company use possible	Cross-company use only possible to a very limited extent
Presently still low level of standardisation	Standardisation completed
Option to develop Internet-applications for RFID systems	
RFID is a highly intelligent logistics solution with many possibilities of application and a lot of potential	
<b>Cost</b>	
Relatively high due to technical equipment required, depends on transponder range	Relatively low
From 50 cent a piece	Total cost remain the same
Strong price reduction expected	
Low personnel expenditure required	Higher personnel expenditure required
Cost sharing supplier-manufacturer- end customer possible	

When analysing the cost of a possible RFID introduction, it is necessary to include functions, options and potential external market pressures. The EU Directive 178/2002, e.g., aims at a high level of traceability of food and beverages by means of effective marking and labelling. The decision on the feasibility of a RFID project will need to be based on the price of the system. Prices are mainly influenced by the type of power supply for the transponder, its range and its integration level into the existing company IT system. These factors depend on company-specific requirements.

Barcoding is an established and proven technology which is currently used to identify 80 to 85 % of all goods and general cargo. At minimal cost (a few cent) labels can be printed and attached to the goods for one-time use.

The use of barcoding is clearly less expensive than RFID at present, however, the system offers far less features and areas of application than RFID. Barcoding can, e.g., not be used on cross-company level.

In addition to the multitude of RFID technology advantages outlined herein (one of the main benefits certainly being the supplementary information provided on the RFID chips), it is expected that chip costs for faster types will drop massively to below one cent per chip. Each company will have to decide for itself on whether or not to implement RFID and base its decision on weighing the advantages and disadvantages of both systems now available.

#### **4. Implementation of RFID – Integration and Difficulties**

There are five factors to be taken into consideration when planning to introduce RFID technology:

- a) Technology
  - b) Organisation
  - c) Legal Issues
  - d) Psychology
  - e) Cost
- 
- a) Users, business associates and customers will need to trust the implemented RFID technology. There is an ongoing debate concerning the potential harm of the radio signals, radiation and interferences of some RFID systems on the human body. Such concerns would need to be dissipated. Media and news reports will be forming the public opinion on this issue.
  - b) Within the organisation, it will be necessary that the RFID system is accepted by the employees, that user training is provided, that the end user is offered a good service, and that a suitable communication strategy is developed and implemented. An absolute prerequisite for the successful realization of RFID projects is a simple, easy-to-understand explanation of how the technology works, and what its applications and advantages are (e.g. the immobilizing technology in cars).

- c) From a legal point of view, it will be critical that the privacy of individuals and of personal data are protected and warranted. The use of RFID systems should therefore not only comply with applicable data protection laws and regulations but should also seek to respect any sensitive personal data.
- d) Whenever new, invisible technologies are developed and launched, there is a certain amount of psychological resistance and fear. An open discussion about the possible abuse or misuse of a technology such as RFID will signal openness and transparency, and will help establish trust.
- e) Comprehensive cost controlling will need to be implemented to be able to compare real cost with long-term advantages and savings potentials.

Prior to the implementation of any RFID system it might be helpful to compare performance, cost and realization barriers of different RFID systems and to determine which product will be best suited to resolve the issues at hand. There are independent and experienced experts available today who can help companies develop and set up tailor-made solutions. One idea is to integrate the RFID system supplier himself in the overall solution, and to agree on performance targets (e.g. the successful read quota). It should be pointed out that many companies will need special, tailor-made solutions to integrate RFID into their existing systems, especially where RFID is to be used in safety-relevant applications.

Workshops can be a good forum to agree on organisational measures, targets, IT requirements, scope of data to be captured, and a suitable schedule. The gradual implementation of RFID, supported by experienced consultants, has proved most successful to-date. Benchmarks in manufacturing companies indicate a project time of 12 months, 18 months if the system supplier needs to be integrated, but the real project time will depend on the level of integration into existing systems.

The realization time can even take longer if a larger number of associates is involved. It took Wal Mart five years to complete changing over to RFID, having integrated all their suppliers. Usually a realization time of two to three years is estimated for trading and retail companies, especially if logistics functions need to be integrated too. Many companies report good results with the trial of industrial handheld systems that read both barcodes and RFID transponders. Staff can work with both systems

simultaneously. This supports learning on the job and encourages trust in the new technology.

## **Integration**

When integrating RFID technology as IT technology, the question of the level of integration of a company's internal process data and external supply chain data into existing IT systems needs to be addressed. The management will need to involve staff and external experts to agree on all necessary measures to create a suitable future-orientated organisation.

IT systems have to be addressed with a view to capacity and efficiency. One feasible solution is to have a decentralized data capture system, integrated into an overall system. Leading IT companies now offer systems which allow direct access of RFID hardware (Device Controlling) to the reading and writing device. Such Device Management Platforms have been specially developed for comprehensive system integration. This means that all data stored on the RFID labels (Data on Network) can be fed into existing electronic data processing systems, for maximum benefit from the RFID system.

Necessary prerequisites for automated data capture and data integration are simple reading procedures, clear and unmistakable identification and interpretation of data, standardization and compatibility. IT system integration can include handhelds, reading devices, scanners, PDAs, mobile phones and a company's IT system itself.

Comprehensive preparation will be required in the IT area concerning the flow of goods and all involved suppliers and forwarders. The data capture within track & trace functions should be realized by means of both centralized and decentralized devices and data storage units. Contracts need to be concluded with suitable service providers, clearly outlining all necessary actions in detail. These usually include costs, schedules, benchmarking requirements, and often also a contract termination scenario.

Integration will have been fully achieved once the RFID transponders, tags and reading/writing devices have been fully linked up via a local IT interface, thus warranting the simultaneous, simple, reliable and flexible identification, controlling

and follow-up on a multitude of objects. Business processes can hence be automatized and optimized.

Should the implementation of RFID be necessary to meet the requirements of an important customer, his system, experience and expertise should be taken advantage of, also where consulting services and cost sharing are concerned.

## **5. Data protection**

The multitude of possibilities of data protection and data storage provided by RFID technology in many countries touches highly sensitive areas of data protection. New statutory requirements influence RFID systems and framework.

This especially affects personal data such as social security details. Such data may include family status, income data, assets, medical details, religious and ethnical backgrounds, criminal records, and much more.

The vast possibilities to allocate and discriminate against individuals have created a public outcry for tighter protection of personal data. On the other hand, there are also some positive aspects: having all personal and medical data (e.g. allergies, prescribed drugs, medication) available in case of medical emergencies. Such details can in the right circumstances help to save a person's life.

Especially in the field of immigration and travel documents RFID will lead to increasing standardization in spite of all public protest. Data protection groups are concerned about the extent and effects of data storage and data networking. The basis for such global data capture will be provided by international treaties and national laws and regulations.

A special focus should be on data covering highly personal information such as medical details and handicaps, behavioural assessments or personal characteristics. The capture and interpretation of such data could easily lead to discrimination (e.g. due to diseases and criminal records).

The application of RFID technology in personal ID-cards, social security cards and medical insurance cards is therefore subject to statutory regulations, strictly limiting the scope of data to be stored on such cards. Such limitations should apply to any

storage of personal data. It is strongly recommended to obtain the explicit personal permission of all those affected when storing their personal data to secure their privacy and protect against data abuse and misuse.

## **6. Consequences on Logistics and the Supply Chain**

This new technology has a major effect on production, logistics, suppliers and the supply chain overall. To merely see RFID as a replacement for barcoding would not do the technology justice. Any considerations of implementing RFID in a company will either be pushed by future-orientated corporate targets, requested by law (in case of food and drugs) or demanded by large customers.

Logistics companies are in the process of aligning their operations to the utilization of RFID, wishing to ensure seamless data capture, recording and controlling of their consignments. Such alignments and adjustments will not only affect the goods to be transported and their packaging (containers, boxes, etc) but also the means of transport and handling (e.g. forklifts, cranes) used throughout the chain. RFID allows the documentation of logistics operations meeting time targets and special requirements such as temperature levels in cold-storage chains. This can also have an effect on customers having to attach RFID labels/tags to their products and packaging.

An even stronger effect on the supply chain will come from large customers both in manufacturing and in trading as and when they start to increasingly demand the use of RFID technology from their suppliers. Suppliers are thus faced with a number of challenges: attaching RFID transponders with EPC global tags to logistics consignments such as pallets and returnable boxes; attaching RFID transponders to trade packaging units such as crates, cases, boxes and also to products themselves if they have a suitable size.

This will leave no other option but to introduce RFID and implement RFID system components for the complete materials management system: RFID printers, RFID transponders for pallets and boxes, reading devices for outgoing and incoming goods operations, adjustments in existing IT systems (middleware and personal computers).

Necessary organisational changes also need to be tackled. Trading and retail chains demand the mandatory use of RFID technology for the following products:

Food, dry food, frozen food, beverages, drugs, electrical devices, cloths, DVD, CD, and toys. Any projects in this field will need to be based on the prior agreements with one's customers and the often costly and time-consuming cooperation with one's suppliers throughout the supply chain.

SMEs may be faced with the problem of being forced to implement RFID to maintain their position within a supply chain. They will need to decide on just how much they can benefit from RFID. When justifying RFID costs, it will not suffice to look at the optimization of stock levels and inventory management because other, less expensive conventional solutions are available for the same purpose. Only a company which can identify a suitable benefit from RFID will also be able to open up the vast potentials this technology offers. For the time being, some SMEs will probably need to handle 80% of goods by means of barcoding systems, and only 20% with RFID. In such a scenario it has proven to be very successful to source the attachment of RFID chips to goods from an external specialist for RFID technology. This solution might also be a general option for smaller SMEs.

Not only can a company benefit from the logistics services of an external specialist but also from the inhouse training they provide. This allows staff to get used to RFID systems while the old barcoding systems is still in place. A later changeover to RFID will be much easier, target-orientated and cheaper after such a transition period. If a large customer puts pressure on a supplier to implement RFID, it is quite usual to try and agree on a suitable level of support and cost sharing.

## 7. Summary

The introduction of RFID technology which uses radio frequency to reliably and unmistakably – and without line of sight - identify, trace and record objects throughout the supply chain offers a multitude of possibilities based on object-specific data storage and data capture: process controlling, authentication, temperature control, user and application instructions, inventory management, logistics, and all other applications mentioned herein. The ability to reuse RFID labels which are weather-resistant and have a long lifetime, is also an advantage. The present disadvantages concerning some materials (metals, liquids/fluids) are expected to be resolved soon by the new methods currently being developed.

Present surveys indicate that more than 10% of all companies with over 500 employees are presently in the Process of implementing RFID technology. This will have consequences for their suppliers and the supply chain.

The advantages of integrated RFID technology which increase with the actual depth of integration can lead to substantial cost savings: Fewer complaints and invoice errors (up to 10%), higher efficiency in production and logistics (up to 10%), better protection against counterfeit (reaching 7% of the overall volume of world trade), less stock deviations (up to 20%), fewer out-of-stock situations (up to 8%), less obsolete stock (up to 2% of sales).

The savings potentials do differ from business to business and depend on the products as well. Only activated RFID tags with a range of 300 metres allow the seamless administration, trading, and documentation of the 400 million containers currently in circulation worldwide.

Only RFID technology can ensure full compliance with national and international security guidelines which request the seamless recording of the flow of goods and cooling temperatures for products such as food and drugs. When introducing RFID it is crucial to integrate the new technology into existing IT systems and to adjust one's organisation accordingly.

Technical and organisational barriers will need to be overcome when introducing goods tracking and tracing systems based on central and decentral devices that

need to be integrated into existing IT-systems. Problems can be caused by the complexity of data processing, the reading rate required, and the handling of handheld reading devices.

In view of the substantial cost of RFID and of the complexity of system integration, many SMEs might decide to stay with conventional barcoding systems for the time being.

Taking advantage of operating inside closed systems, lower costs in comparison are also the reason why more and more large industrial and trading groups can viably utilize RFID systems together with their suppliers and forwarders. Companies which already have an own inventory management and controlling system (e.g. based on barcoding) often do not yet see the enormous advantages to be gained from RFID technology. They might still prefer to operate mixed systems, using external specialists when needing to fulfil customer wishes.

Absolutely crucial for the comprehensive breakthrough of RFID technology will be an increasing level of international standardisation to ensure global compatibility. Further prerequisites will be the safe traffic of cargo and goods and substantial price reductions in RFID equipment. Costs for chips are expected to drop below one cent per chip. Radio frequencies are set to be standardized. Current research is including the use of nano-chips for the global supply chain to be used, e.g., for tropical fruit.

RFID is a groundbreaking technology for manufacturing and trade, and it has only just started to gain momentum.

And this is the RFID vision of the future, once the technology has been fully implemented: Each individual object will have its own homepage and can be reached any time via the EPC network through global data synchronisation (GDS).