White Paper AutoID

RFID positioning within AutoID technology as well as industry-specific approaches to reaching solutions.

Business flexibility T · · Systems · ·

Contents.

1 Introduction.

Radio Frequency Identification (RFID) is an AutoID method. The term AutoID refers to the automatic identification of objects or people.

As is the case with all other AutoID technologies, for example Smartlabel, RFID can essentially be applied wherever data are captured, recorded and administered. Data are then stored on a chip and sent to a recipient, also called a ‘reader’, as needed. RFID uses radio waves for transmission, so that visual contact between chip and reader isn’t necessary. Contactless data transmission is superior to conventional methods like the barcode – this is evident, for example, through a higher possible reading rate or the resistance to (optical) contamination. In addition, more and modifiable data can be stored on an RFID chip.

In practice, RFID has not yet been able to assert itself completely successfully against existing technologies despite its obvious superiority. On the one hand, this is related to the price for the RFID systems and their hardware; on the other hand it is also related to the continuing development of the technology. However, analysts as well as company managements expect this technology to begin a breakthrough in the next few years.

We are going to deal with this topic in more detail below, in order to be able to follow and critically evaluate the current “hype”.

2 What is RFID?

A RFID system consists of an RFID transponder, a reader and an IT system operating in the background. The RFID transponder is also often called the RFID chip or tag, which will be used synonymously in this White Paper.

2.1 Transponder.

A transponder consists of a tiny computer chip and an antenna. A unique number is stored on it and it is attached to an object. A distinction must be made between active and passive transponders.

Passive tags do not have their own source of power at their disposal, and depending on the frequency used, send their data over distances ranging between a few centimeters and several hundred meters. The passive chips are no bigger than the conventional chips found in prepaid cash cards, for example. The passive tags require a slight electrical impulse to be able to send their data. This takes place via a magnetic induction triggered by the reader.

Figure 1: RFID Tag Source: Metro AG

The active tags also have an internal memory and processor at their disposal, in addition to having their own power supply. With that they can attain transmission distances of over 100 meters (328 feet) despite being only about the size of a cigarette pack. The active tags are able to send their data actively because of the power supply and don't require an impulse from the reader.

There are two possibilities in regard to data storage. Depending on the application, data are stored either locally (decentralized storage) on the chip or centrally on an external database. The link to the data record in the database ensues via the unique ID that is stored on the chip (for example, EPC – Electronic Product Code).
In contrast to the classic EAN number that is known from barcodes, an RFID chip can store vastly larger numbers, so that each individual product can be assigned to an own data record. With this, not only can the name and the price of a product group be stored and retrieved, but also individual data such as the sell-by date, the employees involved in the processing, the origin, etc. of the article.

In many cases the significance of their price is discussed in connection with the tags. Analysts anticipate that RFID will assert itself worldwide once a price of under five cents per passive tag is reached. The current prices are still significantly higher.

It is essential to take the area in which the RFID technology is going to be utilized into consideration when discussing the price issue. Thus the cost in a closed chain, for example, in which the chip will be used over and over again, can be amortized. By contrast, the relevance of the tag price in open systems – in which the product doesn't return to the producer – will be greater. The increased spread of RFID technology will result in noticeably lower prices in the future because of the increased quantities.

Particularly the cost for additional hardware (reader, networks, etc.), the technical applicability, the integration of the RFID system with other platforms or processes and the business should be taken into account, as it plays a significant role in the cost-benefit calculation.

	Active	Passive
Power supply	Battery	Radio waves
Estimated useful life	Depends on the battery	Unlimited
Price	High	Low
Memory	Large	Low to medium
Writeability	Multiple	Once or multiple
Range	Far	A few centimeters to several meters
Read speed	Medium to high	Low to medium

Table 1: Differences between active and passive transponders
Source: According to “Basiswissen RFID”, Informationsforum RFID, 2006
[“Basic RFID Knowledge”, RFID Information Forum, 2006]

2.2 Frequencies.

RFID chips send their information over radio waves. Different frequencies are used for this purpose. Nowadays there are many different frequencies, which all have their advantages and disadvantages. Some can be used in the vicinity of metallic objects, others cannot. Furthermore, they also vary in their range, applicability, and much more. Moreover, some countries have not authorized all frequencies. It hasn’t been possible for the governments to come to a consensus on a generally accepted standard because of their extremely varied interests and requirements.

The currently most common frequencies are low frequency (LF), high frequency (HF), ultra-high frequency (UHF) and frequencies in the gigahertz range (GHz). The chips access their appropriate frequency, depending on their application.

Figure 2: RFID Read Gate Source: Metro AG

The currently existing applications and cross-industry standards that the RFID hardware manufacturers can draw upon were compiled by organizations like EPCglobal and the International Organization for Standardization (ISO), and they are continuing to be developed.

RFID frequencies	Applications (examples)	Typical range
LF	Animal identification	1–1.5 meters (3.28-4.92 feet)
Low frequency	Production control	
125-135 kHz	Automation	
	Access control	
	Automobile engine immobilizer	A few centimeters
HF	Commercial goods (individual products)	1–1.5 meters (3.28-4.92 feet)
High frequency	Library management	1–1.5 meters (3.28-4.92 feet)
13.56 MHz	Ticketing (local public transportation, events, ski lifts)	10 centimeters (3.94 inches) + security
	Access control	
	Automation	
	NFC - Near Field Communication	10 centimeters (3.94 inches)
UHF	Pallet identification and box identification (commerce)	Europe: 3-4 meters (9.84–13.12 feet),
Ultra high frequency		USA: 7 meters (22.97 feet)
860-960 MHz:		
Active transponder	Container identification	Up to several hundred meters
(GHz) (with battery)	Production control	

Table 2: RFID Frequencies
Source: According to "Basiswissen RFID", Informationsforum RFID, 2006 ["Basic RFID Knowledge", RFID Information Forum, 2006]

2.3 RFID Printer and Reader.

The data (e.g. the unique ID) are stored on the transponder a single time via a so-called RFID printer. This information is read out again later with the aid of an RFID reader. The reader records the data of an RFID chip as soon as it passes through its read range. Therefore they are also referred to as event-driven data (real time). In the case of passive tags, the reader transmits the electromagnetic impulse that activates the tags. The active chips are always "ready" and send their data automatically.
The readers have to be able to receive the right frequency in order to capture the data. In the meantime there are readers that can read all commonly-used frequencies in one instrument, which promotes the spread of RFID.

2.4 Middleware.

The data captured by RFID readers are relatively worthless by themselves. As is the case in all other AutoID methods, the data have to be processed further and passed on for further processing in subsequent processes. The middleware handles this job. The middleware is the software portion of an AutoID solution that represents the connection between the reading instrument and the existing office systems at the backend (for example, an ERP system).

The transmission of data captured by the reading instrument to the middleware server takes place over the ethernet or WLAN (in the case of permanently installed antennae and readers) or via GSM or GPRS (in the case of mobile utilization), respectively.

The middleware assumes the additional processing of the data. This includes cleaning up reading errors and multiple readings as well as filtering the data according to information relevant to business processes and the subsequent transmission to the ERP systems. With that procedure the middleware fulfills the important job of reducing the data volume that is generally very high in tracking and tracing (people and object location finding) through AutoID methods.

The transmission to the ERP systems takes place promptly, and also in real time, depending on the application, as transactions may have to be triggered from there.

In general, a distinction should be made between centralized and decentralized data management. In centralized data management, only the identification number (Electronic Product Code – EPC) is read from the RFID chip. All other data associated with this object, such as weight, producer or sell-by date, are stored in a database and are assigned to this code via the middleware.

In decentralized data management, all relevant information is stored directly on the chip and can also be modified there. However, the reading operations usually take more time and the transponders are more expensive. The specific application type determines which data management model is expedient and whether or not the access to the centralized data at each read point is warranted. Centralized data management is preferred in the area of consumer goods.

RFID middleware is set up logically in several layers. Each of these levels is assigned its own tasks. Such as, for example, the RFID hardware (reader, antennae, etc.) management, the data and event management and the allocation to the business applications behind them (via defined interfaces).

More and more software vendors are offering middleware products that can be adapted to one's own business processes. There are various application models that are suitable for companies that have decided to utilize AutoID. On the one hand, such a platform can be set up in one's internal IT area. On the other hand, there are vendors who take over the complete hosting of a middleware platform and merely bill for the use (cp. White Paper "Dynamic Services", T-Systems, 2006).

A middleware's utilization and complexity is decided by the planned RFID solution's application. For use in isolated RFID applications, as represented by anti-theft systems for retailers, for example, or protection from forgery, the use of powerful middleware makes little sense, as the RFID data are generally only significant at the point of sale and don't have to be processed further.

If, however, the RFID system serves as part of a supply chain or in other comprehensive processes, the data have to be portrayed transparently, so that these can also be made available to customers, suppliers or other participants, if necessary.

In addition to the necessary integration of the RFID data in a superordinate ERP system, the partners must also be linked via open or proprietary interfaces, so that the larger amount of data – in contrast to the above-mentioned applications – can be processed. In this connection, the middleware also can take over classic EAI platform jobs (Enterprise Application Integration) beyond the purely RFID aspect and control the individual data flow between different end systems.

3 Application areas of and impediments to RFID.

3.1 Application areas.

RFID has some advantages over classic AutoID methods that have been partially described above. So RFID can be used without visual contact, is protected from media disruption and utilizable at longer reading ranges. Reading out is possible at higher speeds. Furthermore, more data can be stored and made available. The areas of application are varied: Object identification, (especially in commerce) logistics and production or person identification, for example in the healthcare area.

RFID extends the spectrum of AutoID methods' applications. However, RFID is not superior to conventional methods in all areas. Here one has to take into consideration that an existing solution will only be replaced when the new technology is clearly better and/or more economical. The faster the Return On Investment (ROI) becomes possible, the sooner the new technology will be introduced. If one thinks about this fact, the reason RFID is having a hard time asserting itself in relationship to the barcode becomes clear. The barcode was able to establish its right to exist by virtue of its high level of reading reliability and the low price.

Using RFID hardly represents any significant time savings in applications in which the product will continue to be checked manually by an employee. However, the utilization of RFID in scanning various products on a pallet is much more efficient, because not every individual product has to be read in manually. It is to be expected that both solutions will continue to exist side-by-side for a long time.

3.2 Current Impediments.

There are several reasons that a broad RFID coverage has been hampered up to now. For example, privacy watchdogs note that RFID is the next step towards customer surveillance. The concern is that data of purchased products can be read without the purchaser's knowledge by positioning the readers shrewdly. These misgivings cannot be dismissed out of hand because of the contactless data transmission, but they are unfounded as long as only identification numbers and no personal data are transmitted. A code of conduct self-imposed by the companies (e.g. "transmitting" labels designation) is intended to provide more transparency. A further obstacle for companies is demonstrated by the still missing investment safeguards. The constantly evolving technology can result in incompatibilities between currently available and anticipated systems.

Many experts predict a price of five cents per passive tag. The constant emphasis on the price as the main obstacle has caused many decision-makers to wait with the introduction until that price is reached. This has resulted in the "chicken-or-egg" question because the prices can only go down when the unit numbers are high. The focus on the tag price, however, is right to only a limited degree. A not insubstantial part of the cost arises from the acquisition of the remaining hardware, the network infrastructures, the conversion of the systems and the operation of the complete solution.

An RFID application can't be judged across the board. Cost-benefit considerations vary sharply from industry to industry and their potential areas of application. In this connection we will illustrate a few application examples in selected industries.

4 Which specific scenarios are there for RFID?

This chapter shows where RFID is already being utilized, where it is not worthwhile from our point of view and where it can be utilized in the future.

4.1 Automotive.

A classic example of an RFID application is the electronic engine immobilizer. An RFID chip is built into the car keys. The reader is integrated in the ignition lock and connected to the engine's electrical system. When the driver approaches the car with the key, the reader recognizes the chip and switches off the electronic engine immobilizer. When the driver gets out of the car and then out of the reader's range, it automatically locks. In contrast to mechanical and electrical security alternatives, the engine immobilizer can no longer be deactivated by simply hotwiring or cutting individual cables.

RFID also has applications in automobile production. Here especially expensive production parts or their means of transportation are equipped with RFID chips. Reading instruments at the exits ensure that these can be localized any time. This procedure is primarily applied to special containers. The loss rate has been significantly reduced through the use of RFID.

Larger supplier products as well (for example, seats or cockpits) are identified by RFID in order to achieve an optimized just-in-time delivery. The advantages over the barcode are currently being defined in cross-company pilot projects.

The utilization of RFID in the automobile sector could increase rapidly in the future. It is conceivable that every crucial part in a car will one day contain an RFID chip. In the case of maintenance, a component can be unambiguously identified by this chip without a complicated dismantling, which in turn determines whether replacement of the part is necessary.

4.2 Retail.

RFID is already being used in some areas of the retail sector, too. The retail sector was one of the first economic branches to discover the advantages of RFID for itself. Big retail chains are just in the process of putting RFID chips on their products in addition to the barcode. That way the retail chains can control the flow of goods better and also reduce costs. While pallets used to have to be recorded individually, it now suffices to push the pallet through a reading gate. The big chains are currently the only ones benefiting from utilizing RFID. However, the chips primarily only signify higher costs to the suppliers and manufacturers who are responsible for labeling their products. Optimizing the infrastructure and production processes with the help of RFID technology, though, can also benefit the suppliers and manufacturers.

Figure 3: Hanging sorter with tagged articles of clothing Source: Metro AG

RFID is better positioned in the textiles sector. The main reason for that is that there was no possibility of identifying clothing directly before now. Up until now the barcode was printed on the labels for identification, because there is a very high error rate when they are printed directly on the clothing. It is now possible to identify clothing from production to sale using the RFID chip. This involves sewing a chip invisibly into the clothing. When loading the clothing, which objects are being sent in what quantity can always be checked. In addition, the end customer can access further information on the article at information terminals in the store.

Figure 4: Changing room in the Metro Future Store Source: Metro AG

However, using RFID is not needed everywhere in the retail business. The so-called egg database, in which the entire life cycle of an egg to the chicken farm and feed producer is documented, only works with printed number codes. These refer to information that is stored in a shared database. Consequently, the most economical and practical method was selected in this case. It is precisely in the identification of low-price products that the tag price represents a barrier.

Should the price continue to move lower, it is conceivable that the dreams of some retail chains will become reality. It is anticipated that all wholesale and retail products will one day be equipped with RFID chips. Furthermore, it is assumed that all suppliers and manufacturers will integrate RFID in their production processes and therefore reap the full benefits.

The consumer benefits principally from the increase in available information. For example, it will be clear to each end customer how, where, by whom and when each product was made. In addition, general information on the product can be viewed at the respective RFID terminals. The manufacturers can react to demands from the EU in regard to back-tracing goods with it.

4.3 Logistics.

There are already several RFID versions in use in the logistics industry. Because of the events of September 11, 2001, the US authorities have intensified security measures regarding the import of goods. Effective January 1, 2007, the 'passing of risk' of all containers has to be documented every time. The transfer from one accountable person to the next is designated as 'passing of risk', for example from the transportation company to the shipping company, whereby each is always only responsible for the person(s) coming directly beforehand and afterwards. The simplest way to deal with the documentation is directly on the RFID chips. All containers are equipped with active tags. Not only the passage documentation but also the container's contents are stored on it. The tag simplifies the shipping company's work in particular: The containers can be located more quickly and errors in loading/unloading are minimized with RFID.

In addition, linking an RFID system and a GPS system facilitates constant information on the container's whereabouts. To do that the RFID system identifies the container unambiguously, and with the help of the associated GPS, the exact position coordinates can be determined and transmitted to an appropriate service platform. The procedure involved in locating objects and also persons this way is called Tracking und Tracing. Tracking and Tracing can also be used in closed spaces, for example in a warehouse. Then the RFID system would be connected to a WLAN. All these functions serve to exercise constant control and are mainly used on high-value objects.

Packages and other objects to be sent are also outfitted with RFID chips. In the meantime, some package delivery services also use this service as a selling point. As an example, a major transportation company advertises its ability to provide non-stop information on the exact location of its freight.

Figure 5: Loading Ramp with Read Gate Source: Metro AG

In the future all containers could be equipped with RFID readers. Each loading and unloading of the container could be followed – provided that all products have an RFID tag. This scenario, however, requires an extremely broad-based RFID implementation and will only be financially viable if the traditional manual freight control methods can be largely dispensed with.

4.4 Public Sector.

In the public sector, libraries and museums were the first institutions to use RFID, especially to increase the convenience for the visitors and customers. Books and other media in libraries are fitted with an RFID chip. This way the articles can be checked out in conjunction with an ID card that also has RFID, by passing them through a read gate. This reduces waiting periods and theft.

Works of art in museums are equipped with RFID. A visitor can get interesting information about the artwork by using the appropriate reader (in the future in the form of cell phones or PDAs, for example). This would also be possible by entering numbers or barcodes, but with less ease.

Another RFID application area in the public sector is the new e-passport. This contains additional biometrical data about its owner. For security reasons it is not adequate to simply print the data on it for everyone to see.

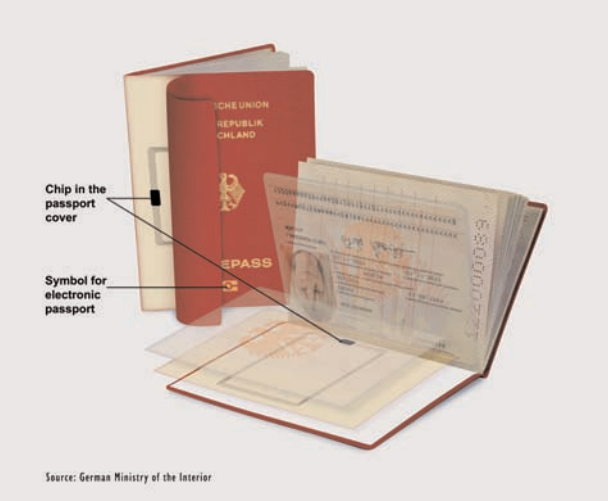

Figure 6: E-passport
Source: Federal Printing Office/German Ministry of the Interior

Tests between conventional chip cards and RFID-able IDs showed that the latter are more resistant to wear and are therefore more durable over time while maintaining a constant accuracy in readability.
European passports will be fitted with RFID for that reason. In order to prevent misuse of data, the chips only send their data when the identification has been manually scanned in via optical signals beforehand. Only then will the reader send the read impulse.

4.5 Healthcare.

The utilization of RFID in the healthcare sector began with the optimization of asset management processes. As a result, some hospitals have equipped their beds with RFID. Prior to that, a sign was put on the beds by the cleaners to show if the bed had been cleaned and disinfected. As these signs were easy to remove and some beds were put into interim storage, it was not always obvious if a bed had been cleaned yet or not. Therefore many beds were cleaned multiple times. With RFID, the status and location of a bed are always evident by being stored on the chip or in the system. In addition, the critical points, such as the passage from operating room to recovery room, are equipped with read gates.

A further example of how RFID is applied in hospitals is the identification of stored blood. To eliminate the risk of administering the wrong blood type, some stored blood is not only identified by a classic label but also by an RFID chip. In contrast to the labels, removing chips integrated in packaging is not possible.

To ensure that patients are provided with the correct blood type, it is conceivable that each patient will be given an RFID bracelet to wear upon being admitted. In addition to the blood type, the bracelet would contain other important information about the patient, for example, identification, possible medical incompatibilities or allergies, in addition to the diagnostic findings. The doctor would then be able to call up the patient information any time via a handheld reader.

The use of RFID in hospitals could become more extensive in the future. It is conceivable that all instruments used in the operating room – up to and including the cotton swab – will be equipped with RFID. An RFID reader could ensure that no object has been left in the patient's body after an operation. However, this example of RFID use is extremely dependent on the tag price.

5 Conclusion.

RFID falls seamlessly in the line of AutoID methods; it involves an additional opportunity to identify objects or people. However, because of the freedom from direct contact, visual contact and media disruption, the application possibilities of AutoID have increased. So automatic capture is now possible in some areas in which manual intervention was required until now. The increase in storable data volume also results in new application options.

The usability of RFID also has limits. Conventional AutoID is still more sensible in many areas. A discerning examination of the cost-benefit ratio is necessary for each planned application. RFID will gain in market share, but won't replace the other AutoID methods in the market completely. Should technical development continue, the applications potential will increase further and the price of RFID systems will decrease. The declining price not only applies to the tag price, but especially to the price for implementing the solution and the hardware. This will result in RFIDs being not only technically superior, but a faster Return On Investment will also take place. Whether or not the "hype" will prove true is difficult to estimate; however, one has to grant that RFID has great potential. It's entirely conceivable that RFID will fulfill expectations.

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