1

Introduction

Radio frequency identification (RFID) is a seemingly simple technique. Data is stored in RFID tags that are attached to objects or located in smart cards, and this data can be read using radio signals and presented on a display by using a suitable reader. The data can then be transmitted automatically to an information technology (IT) system for further processing. Although this method is easy to describe in technical terms, there are many obstacles in the areas of application technology and integration into operational processes that must be overcome before it can be used operationally. For this reason, this book concentrates primarily on the potential economic benefits that can be realized from improvements to business processes that can be achieved using RFID, rather than on the technical aspects of how RFID tags and readers work and what they do. Our objective here is to examine RFID technology as a whole in the context of enterprise processes and higher-level IT systems.

There are essentially two groups that are interested in using RFID technology. The first group consists of the innovators, the advocates of new technology, who argue that it can create added value in the form of short-term or long-term benefits. They incorporate RFID technology in their strategic plans and start experimenting with it at an early stage. Other enterprises, by contrast, find themselves forced to introduce RFID because their customers demand it, for example due to the policy of mandated requirements pursued by large retail groups. In addition, they are afraid of losing ground to competitors and missing out on competitive advantages. In terms of marketing theory, the first group is referred to as the innovators, visionaries or early adopters, while the second group is referred to as the 'conservative majority' or 'laggards'. They are also called the 'fast' and 'slow' groups [Moore96].

In this book, RFID is regarded as one of several auto-ID technologies that can be used to identify objects or persons. It is not our intention here

RFID for the Optimization of Business Processes Wolf-Ruediger Hansen and Frank Gillert

to create the impression that RFID is always the ultimate solution. We are convinced that barcodes still have a long life ahead of them and that they will be used alongside RFID in a complementary fashion, particularly in trade environments.

The debate on the potential success of RFID technology is not aided by the fact that a global media hype has developed on the subject of RFID. For one thing, this hype fosters fear of losing control over how personal data is used and reduces willingness to accept new technologies. It also encourages enthusiasts to devise unrealistic scenarios and lose sight of circumstances that constrain the use of the technology, in particular physical constraints. However, euphoric behaviour of this sort is often seen when a new technology is introduced. A US marketing research company, Gartner, has developed a model of the hype cycle in order to describe this phenomenon. The RFID hype cycle is described in Chapter 2, 'Visions, Reality and Market Drivers', which also shows that there are many ways to put RFID technology to good use, even if some approaches ultimately land in the 'trough of disillusionment' as often happens with innovative technologies.

If you follow the public statements of the industry consortium EPCglobal and its members – e.g. retailers such as Wal-Mart and Metro – you often get the impression that RFID is already in common use. However, this is not so. Here it is important to recognize the correct context for viewing the various aspects of RFID applications. Up to now, the key significance of the RFID innovation project of the Metro Group lies less in the actual implementation of RFID methods than in their comprehensive portrayal of the capabilities that could be made available to retailers in the medium to long term, not only in branch outlets but also along the entire supply chain. With its commitment to RFID, the Metro Group has created an internationally communicated image as an innovator. In the view of the international market, this puts it at the same level as much larger groups such as Wal-Mart in the USA. This should be regarded as an aspect of corporate strategy, and in particular as a way to send a message to the stock markets. Information about the status of the project and the accumulated experience and insights gained from it are reported quite extensively in Metro's freely available *RFID Newsletter*, which appears several times a year [Metro2603].

Another factor that blurs the issue, and which is an unintended result of the extensive publicity efforts of the EPCglobal consortium, is the fact that EPCglobal's market activities are often regarded as generally representative of all possible RFID solutions. They should instead be seen in perspective, because there are many areas – such as production control systems in manufacturing companies and smart card applications – that lie outside the sphere of influence of EPCglobal. Anyone interested in the subject is well advised to acquire a good understanding of the various aspects and players in order to obtain a balanced view of the

RFID situation. The applications described in Chapter 10 also provide a suitably broad overview.

In the EPCglobal domain, which means in the retail sector and other directly related sectors, practical implementation of RFID techniques is proceeding much more slowly and with much more effort than what can be seen at first glance. In the press and at trade fairs, attention is often focused on individually tagged items. We see them being placed in special shopping carts, which must be made from plastic so the antennas will not be screened by the metal grids normally used for this purpose. Then we see how the items are automatically identified at the checkout and a receipt is generated 'on the fly'. This scenario is still a fantasy, as according to Metro's own statements it will take at least five years before comprehensive item tagging becomes generally established. As an exception to the situation in the EPC world, clothing articles are increasingly being tagged at the item level. In the retail sector, the primary interest at present is on tagging pallets and cases, which addresses logistics issues. Outside the retail sector, one example of an application where RFID tags are already being used successfully is in identifying books. The current process drivers for RFID technology are described in Chapter 2.

Chapters 2, 3 and 4 are largely devoted to logistics aspects, since this is where the greatest potential benefits are expected to be found. However, the situation is complicated by the fact that the potential benefits can only be realized if the various enterprises in a particular supply chain can agree on comprehensive solutions. Consequently, decision-makers in these enterprises need more support with projects that involve using RFID in logistics chains – which means planning 'open' systems – than with projects that involve using RFID to support internal processes ('closed' systems), such as in production control environments.

One of our specific objectives in describing logistics aspects is to help small and medium-sized enterprises (SMEs) understand the process-specific context so they can start participating in the RFID processes of the major players in a timely fashion. For their part, the large retail groups must include SMEs in the process if they want to see their RFID strategies realized in the end. They will pursue this goal by using more or less gentle persuasion ('mandated requirements'). For players in the SME sector, it is thus important to be prepared for the introduction of RFID in order to avoid the risk of losing customers due to insufficient technological adaptability.

The potential benefits that can be seen in the market are discussed in detail in Chapter 3. There we describe the market structures, value chains and foreseeable market consolidations in order to give users a better understanding of why suppliers act in particular ways and the strategies they develop to position themselves in the market.

Chapter 4 presents a highly detailed view of planning and process structures, which above all will force supply relationships to change

from the existing pattern of bilateral relationships between suppliers and customers to a pattern of multilateral network relationships – the 'supply net'. Using RFID technology is also expected to eliminate a well-known shortcoming of the retail supply chain: the 'bullwhip effect'. This effect occurs because the volumes of merchandise sold in branch outlets and held in intermediate stocks or by suppliers are systematically overestimated or underestimated. In the first case, this generates excessive stock levels, which tie up significant capital and always lead to asset losses, for example when goods can no longer be sold because they have become outdated in stock. In the second case, it results in stock shortages that lead to empty shelves (out-of-stock items). The net result is a combination of avoidable costs and lost revenue, which can easily consume an already narrow profit margin.

We also discuss planning and process structures that can be supported especially effectively by RFID methods and can be utilized either incompletely or not at all in the absence of RFID, such as vendor-managed inventory (VMI), efficient consumer response (ECR), and collaborative planning, forecasting and replenishment (CPFR). As can be seen from this discussion, enterprises that cannot agree with their trading partners on transparent management of supply chains are also not sufficiently mature to use RFID technology. Based on these general approaches, we then examine the potential benefits in more detail. We discuss suppliers in the packaging industry and service provider structures. This is followed by an in-depth look, at the subprocess level, of analytical models for assessing economic viability.

Data processing in IT systems always involves identifying the objects for which the data is to be processed. Introducing RFID leads to serialization of the objects, which means that individual objects can be identified uniquely. The barcodes presently used in merchandise systems only allow the product type to be identified. A barcode consists of a manufacturer number (producer) and a product number (object type). Schemes such as the Electronic Product Code (EPC) can be introduced with RFID systems. This code includes a serial number in addition to the other data. This makes it possible to distinguish one bottle of apple juice from another one next to it – every bottle has a virtual identity. The EPC strategy is the focus of Chapter 5.

In the case of apple juice, it might reasonably be asked whether this serialization is worth the effort. However, it becomes a lot more sensible if you consider medicine packaging. Besides the logistics benefits, one of the objectives here is to protect products against counterfeiting, and particularly in the pharmaceutical sector to maintain pedigrees (e-pedigrees) that describe a product's history from production through the entire retail supply chain to the consumer. Here pharmaceutical products must be handled in the same way as technical replacement parts for cars or aircraft. Pedigrees also allow recall campaigns to be

conducted more specifically and efficiently than is presently possible. This yields benefits for consumers as well as enterprises. For all of this to be possible, it is necessary to develop standards that accelerate global participation of enterprises in using RFID technology. These aspects are also discussed in Chapter 5.

The 'internet of things' is a complex structure. In order to understand its manifestations in public IT structures and IT structures inside enterprises, it is helpful to understand how to interpret architectural terms in the IT context. Chapter 6 is dedicated to this objective. Based on the historical development of IT architectures, we show that many structural elements necessary for novel RFID applications are actually not all that new. Seen from this perspective, RFID is simply a medium for transmitting relevant event data necessary for handling operational processes directly and automatically in IT systems. After the data has been input into the system, further processing of the data does not depend on the technology used to acquire the data. However, data processing and database updating can be performed closer to real time with RFID. Mapping of real-world business processes into IT systems is thus more realistic, and IT systems can do a better job of performing their control tasks.

Agent technology provides IT architectures with a completely new, decentralized structural element. Agents are independent software modules that can be used in local or mobile environments. They are autonomous instances that become active without centralized control by IT systems. Agents can be used in the edgeware domain, in readers or even in the actual objects if they are equipped with suitable processors. As an example that illustrates the role of agents and how they work, we describe an industrial conveyor system that independently determines successive destinations for routing individual containers along a branched conveyor belt system according to the necessary processing steps or available capacities. The agents in this system also communicate with each other via RFID.

A paradigm shift with regard to operational information systems is currently taking place in this area, and it requires new ways of thinking on the part of system managers. Up to now, operational information systems have been implemented using centralized approaches. Enterprise resource planning (ERP) systems, and in particular the systems supplied by market leader SAP, are perfect examples of this. By contrast, agents perform control tasks independently and thereby decentralize process control. RFID technology also has a decentralizing effect even without introducing agents. This can be seen from the increasing availability of supply chain management (SCM) software packages that run in the edgeware domain close to RFID readers instead of in the background on a mainframe computer as in the past. It is thus advisable for anyone involved in innovative use of RFID technology to acquire an understanding of these aspects of decentralization.

Chapter 6 concludes with a description of on-demand services. This is because many enterprises, especially those in the SME sector, are more likely to yield to the pressure of innovation than to entrust operation of their IT systems, either entirely or in part, to external service providers. This is usually called 'outsourcing', but the term 'on demand' is becoming increasingly common in connection with this form of service provision. It is intended to convey the idea that a good service provider always supplies exactly the amount of IT support needed by the customer organization, and, more importantly, only charges for this amount of support.

In Chapter 7 we turn our attention to the hardware infrastructures of auto-ID and RFID systems. We are convinced that it is helpful to understand the basic features of the technical structures of RFID tags and reader antennas and the processes used for communication between them. An especially critical aspect here is the 'air interface', which is the electromagnetic field between the antennas of the tags and readers that is used to transmit data. This field is governed by unyielding physical laws that must be respected by enterprises when they are planning RFID systems. Reader manufacturers often give the impression that it is only a matter of time before their readers reach a level of technical sophistication that enables them to resolve every reading problem. For their part, producers of RFID inlays (combined chip/antenna modules used in RFID tags) suggest that they will soon discover the mythical philosopher's stone by fashioning the antennas (in this case dipole antennas on UHF inlays) in the form of especially imaginative fractal shapes. Although improvements can be achieved in all areas here, it must be borne in mind that the read fields of the antennas are subject to physical laws, with the result that disturbances by metallic objects or even liquids can make operational use impossible due to inadequate read reliability. Simply rotating a case by 90° can cause its transponder to fall outside the range of the antenna – not because the distance is greater, but because the resulting 90° angle between the RFID tag antenna and the reader antenna reduces the effective range. Relevant results obtained from experimental systems are described in Chapter 7.

The evident technical limitations on process optimization must be compensated by using process-specific measures. In particular, requirements for attaching tags to packages and arranging packages in containers or on pallets must be specified precisely, and these requirements must be obeyed. In this regard, RFID methods can also fail due to a lack of employee discipline or inadequate training. Section 7.4 deals with these requirements for successful RFID implementation.

In Chapter 8 we highlight the essential statutory provisions with regard to consumer protection and data protection in Germany. However, we are convinced that the vast majority of operational application scenarios for RFID have little or no relevance to consumer protection. In the retail merchandising environment, special caution is of course necessary

if comprehensive labelling with RFID tags is ever to become generally established. However, this is still several years away, as already mentioned. Consumer-oriented near-field communication (NFC) applications, which are discussed in Chapters 7 and 10, could spread more quickly. Consumer protection is naturally very important in this area.

Some fear scenarios with regard to inadequate data protection in RFID applications can easily be put into perspective. They arise in part from inadequate communication by enterprises regarding the use of RFID tags, and in part from ascribing capabilities to the technology that it simply does not have. For instance, it is quite difficult to even read RFID tags attached to articles of clothing without this being noticed, and even if this can be done, it is difficult to do much with the information because the tags usually contain only item numbers. Data stored electronically in e-passports can only be recognized after the text information has been read optically.

Attempts to store large amounts of data in tags should be met with scepticism. All information about objects or persons that can be identified using RFID tags or smart cards can be made available in databases accessible via the Internet. This data will be collected there anyhow, independent of the use of RFID. Storing a large amount of data in a RFID tag prolongs the read process, which is a disadvantage in the logistics environment.

Chapter 9 extends Chapter 8 by presenting a global overview of RFID legislation in the USA and other countries based on recent research activities at the Technical University of Darmstadt, Germany. It was written especially for this English edition of the book by Professor Viola Schmid, whose research areas are cyberlaw, e-justice and freedom of speech. An interesting point here is that the US Food and Drug Administration has extended its view beyond RFID to include nanotechnology, encryption technologies and other methods.

Finally, in Chapter 10 we invite the reader to join us on a tour of applications that have already been implemented or will be implemented in the near future. In that chapter, as in all others, our aim is always to encourage readers to let the contents stimulate their imaginations and create links to similar circumstances or situations in their realm of experience and professional environment.

In addition to the list of references, the appendix includes a glossary of the most important terms and abbreviations and a directory of Web addresses intended to help the reader learn more about RFID.