

# Making Waves: RFID Adoption in Returnable Packaging

*"Who am I to believe about the speed of introduction of Radio Frequency Identification (RFID) in the world of CPG and RETAIL?"*

*"Will RFID give me added value in the form of reduced costs, improved quality or an increase in my turnover?"*

*"In which business processes is RFID the real driver for substantial benefits?"*

*"Should I wait for the early adopters or should I become one myself?"*

These are just a few of the questions that are on the minds of manufacturers and retailers. LogicaCMG has explored these issues in the RFID Benchmark Study that you now have before you.

From October 2003 to March 2004, a team of senior consultants and managers worked on an extensive European RFID study into the strategic and operational processes used by over 50 manufacturers, retailers and logistics companies in the CPG and retail industry. The use of RFID in returnable transport items (RTI) was central to this study, where practical feasibility of business cases was a key element.

It is my sincere conviction that this report provides answers to many business questions and presents arguments to support you as you decide if and when to use RFID in your business. The in-depth analysis of the interviews found in chapters 5 and 6 is directly relevant when formulating a RTI strategy for your business.

One of the most important conclusions of the study is that the use of RFID in returnable transport items is an irreversible process and involves the entire supply chain. As demonstrated by the representative business cases, developing an RFID strategy is a must for many companies. I would advise you not to wait too long to get started.

Concluding my preface I would like to thank all the companies who contributed in any way to this study.

I hope you enjoy reading it and can use it to your advantage!

Paul Stam de Jonge  
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## Colophon

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LogicaCMG is a major international force in IT services and wireless telecoms. It provides management and IT consultancy, systems integration and outsourcing services to clients across diverse markets including telecoms, financial services, energy and utilities, industry, distribution and transport and the public sector. Formed in December 2002, through the merger of Logica and CMG, the company employs around 20,000 staff in offices across 34 countries and has nearly 40 years of experience in IT services. Headquartered in Europe, LogicaCMG is listed on both the London and Amsterdam stock exchanges (LSE: LOG; Euronext: LOG). More information is available from [www.logicacmg.com](http://www.logicacmg.com)

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## Management Summary

Wal-Mart, Albertsons and Target - three of the four largest retailers in the United States- require their major suppliers to deliver all pallets and cases with Radio-Frequency Identification (RFID) tags, starting in 2005. Improved supply chain visibility, more efficient processes and higher turnover are the benefits these companies anticipate achieving. The impact on the retail supply chain is enormous.



Many retailers, manufacturers and logistics service providers wonder when 'Europe' will reach this stage. In this study we answer part of this question.

The starting point for this study is the retail supply chain, consisting of suppliers, manufacturers, and retailers. The focus is on reusable packaging, or more specifically, returnable transport items (RTI), such as pallets, crates and roll containers. We anticipate that producers will fit these items with RFID tags relatively quickly, because the tags can be reused. Returnable transport items are widely used in the European retail supply chain, often in a common pool managed by a pool organiser or logistics service provider.

In this study, LogicaCMG has worked closely with EAN Nederland and ECR D-A-CH. Between November 2003 and February 2004, we interviewed fifty organisations in six European countries. These interviews are complemented by a cost/benefit analysis and a study of the available literature. It is the most in-depth investigation of this subject in the European retail market conducted to date.

In this management summary we discuss the following matters in brief:

- RFID advantages and applications
- Findings from the interviews
- Technical limitations
- Consequences of implementation.

## RFID advantages and applications

RFID technology is based on a relatively simple concept. It consists of two elements that communicate through radio transmission: a tag and a reader. The tag contains a small chip and an antenna and can be placed on any object. The information on the tag, such as an identification number, can be transmitted to an RFID reader over a distance of a few metres. The readers are placed in various locations throughout the supply chain, such as at the doors of a distribution centre. RFID technology makes it possible to identify and track objects without time delays

and without human intervention. In principle, companies can optimise the logistics process better with RFID than with barcodes, the traditional method of identifying objects within the supply chain.

When using RFID for RTI's, we distinguish two applications: asset management of the RTI pool, and tracking the flow of goods.

RTI pool organisers primarily benefit from better asset management, for example by reducing safety stocks. Tracking the flow of goods with RFID provides a number of advantages for retailers and manufacturers, including efficiency improvements in distribution centres, fewer errors, and better tracking and tracing for food safety.

The costs and benefits of these applications have been quantified in a generic supply chain model, concentrating on reducing safety stocks and improving efficiency in handling. The investment consists of RFID tags and readers. We conservatively estimate these at 0.50€ per RFID tag and 30,000€ for the installation of RFID readers at each point in the chain, and these prices will drop further in coming years.

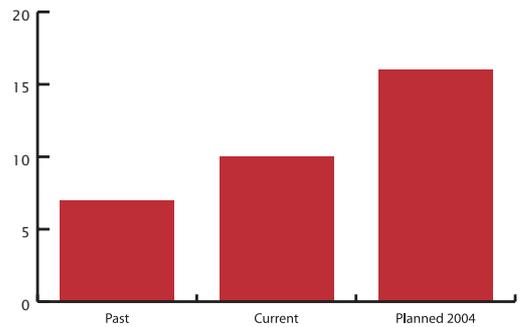
In the generic supply chain that we studied, the use of RFID on RTI's gives a positive financial result. The advantages are primarily gained in the distribution centres and at RTI pool organisers. The payback period for the investments is between two and three years. Section 6 contains detailed information on this cost/benefit analysis. In reality each situation will be different, making it very important for each organisation to conduct its own cost/benefit analysis.

## Findings from the interviews

Given this positive financial analysis, it is important to see whether companies will actually start to implement RFID in their organisations. The interviews reveal the following:

- The number of RFID pilots increases significantly in 2004. Out of the companies interviewed, almost 50 % will gain experience with RFID in a pilot project in 2004.

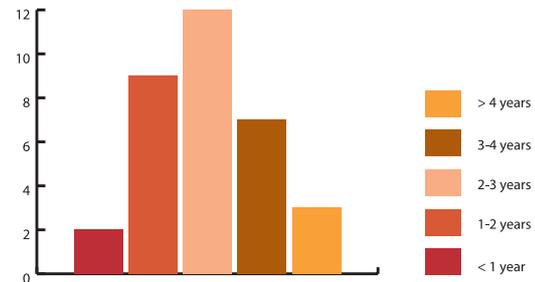
Organisations with RFID pilots and implementations



- Eleven companies anticipate starting implementation before the end of 2005. The majority of the followers expect to start within two to three years from now. The UK is ahead of the rest of Europe.
- We expect that crates and cases will be fitted with RFID tags before pallets, because this provides more value to retailers.
- The majority of the early adopters support EPC (Electronic Product Code) as the data standard and UHF (Ultra-High Frequency) as the frequency for open supply chain applications.
- The early adopters have a long-term vision and expect additional benefits to become clear after implementation. There is currently a big gap in knowledge and vision between the early adopters and the followers.
- Because RFID implementations impact the entire supply chain, the work of the early adopters will create a snowball effect. It is important for all companies to obtain experience with this technology in the short term.
- The use of RFID in RTI's will start with new products brought to market, because migration is not an issue.

These findings indicate that companies will implement RFID on a large scale in the next few years, driven by the large retailers and pool organisers. Section 5 contains a complete overview of the findings of the interviews.

Expected timeframe for RFID implementation in the organisation



## Technical Issues

There are still many misunderstandings about RFID technology that can sometimes, unfairly, lead to scepticism. Our analysis reveals the following issues:

- There is no clear choice of frequency. UHF is the most appropriate for supply chain applications, but the question remains whether this technology can be used in environments with a lot of water.
- Standardisation has not yet been finalised, despite the recent progress with the EPC standard.
- The use of UHF technology in Europe is very limited to date due to restrictions in European legislation. As a result, the UHF products currently available are relatively immature.
- Software to integrate RFID with business applications is currently not fully developed. In a few years, this will become a standard part of ERP, WMS and supply chain management applications.

We expect the issues with standardisation and European legislation to be resolved by the end of 2004. From 2005 onwards, reliable UHF products will be available on the European market that meet these standards.

## Prerequisites for implementation

The implementation of RFID has far reaching consequences for organisations and demands fundamental preparation. The preparation time is relatively long at the moment, due to the immature technology and the limited experience



with RFID. A proven step-by-step implementation is effective: from study or proof of concept, pilots, small-scale projects to large-scale rollout.

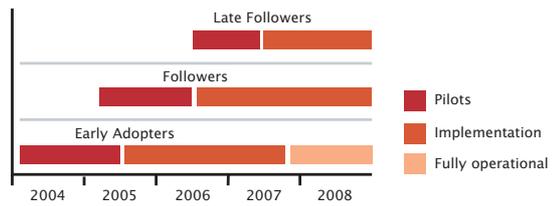
Consumer privacy is not directly an issue with RFID on returnable transport items. However, there is a risk of misconception about RFID technology among consumers. As part of their RFID strategy, retailers and manufacturers need to develop a privacy policy and communicate this to their consumers.

Before RFID can be implemented on a large scale, the technology must be 100 % reliable and the parties involved must have an insight into the breakdown of costs and benefits. System integration is also necessary, including possible data synchronisation with clients and suppliers.

Various organisations fear a shortage of engineers in Europe to install the hardware for large-scale implementations. Additionally, fitting the existing RTI pool with RFID tags will be difficult and time consuming.

## Conclusion

RFID adoption roadmap



Because of the fundamental advantages, companies will gradually introduce RFID technology in supply chain applications over the next few years, despite the current technical and organisational issues. It will require a lot of effort, but the early adopters, mainly large retailers and RTI pool organisers, are already starting. These implementations have an impact on the whole chain and will lead to an irreversible process. The followers, who are currently still just watching, will also implement RFID over time. Because of the far reaching consequences, these organisations should gain knowledge and experience as quickly as possible. The diagram above provides a graphic representation of the anticipated implementation of RFID.





## 1. Introduction

The idea for this study arose from a question about the plans from European retailers for RFID tags on plastic crates. It quickly became evident that there was great interest in this subject in the retail industry. That is why LogicaCMG decided to investigate this question in cooperation with EAN Nederland and ECR D-A-CH. EAN, well known for its standardisation work with the barcode, and ECR D-A-CH, the German-language representation of the Efficient Consumer Response (ECR) movement, both play an important role in the retail industry.



Their support and expertise have been essential in the creation of this report. We also found Intermec, Omron, Checkpoint Systems, Zetes, SAS, Container Centralen and Euro Pool System willing to make the study financially possible, for which we are very grateful.

Radio Frequency Identification (RFID) is currently of great interest thanks to the initiatives from Wal-Mart and other retailers to require major suppliers to place RFID tags on cases and pallets beginning in 2005. In addition, food safety concerns have generated a greater need for tracking and tracing of products, which may be enabled by RFID.

For this study, we concentrate on plastic crates, pallets and roll containers, summarised by the term Returnable Transport Items (RTI). Consequently, disposable packaging, bottles and individual consumer items are outside the scope of this study. We thus arrived at the following question for the study:

"To determine when and how RFID will be adopted for the European retail market on a large scale for use in returnable transport items (RTI)".

This question needs to be further specified: it still leaves space for a broad interpretation of the various aspects.

This brings us to a second question: from what angle will we approach the question to be studied, from the viewpoint of an individual organisation or from the supply chain? In this study, we decided to use the supply chain approach. The reason for this is simple: returnable transport items are often used across several links in the supply chain.

## 1.1 Study Methodology

In answering the study question, we used three main elements:

1. Interviews with 50 organisations in Western Europe.
2. Literature study; Appendix 4 gives an overview of sources.
3. Cost/Benefit analysis, based on a generic supply chain model.

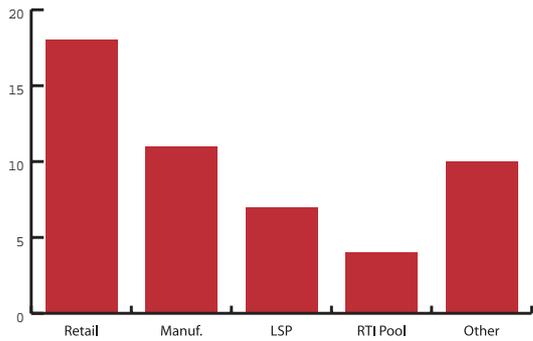
A total of 50 organisations were interviewed for this study, including retailers, manufacturers, logistics service providers, RTI pool organisers, technology providers and industry bodies. The focus has been on retail organisations, as can be seen from the overview below. Retailers are expected to play a key role in the introduction of RFID, as illustrated by Wal-Mart in the United States.

Element	Definition / Description
Retail	All companies in the retail and consumer packaged goods (CPG) supply chain, (retailers, logistics service providers, manufacturers). Special consideration for the (fresh) food segment, which makes great use of reusable packaging.
Europe	This study focuses on the following countries: the Netherlands, Belgium, Ireland, United Kingdom, France and Germany.
RFID	Radio Frequency Identification.
Returnable transport items	Primarily focusing on pallets, roll containers and crates.
On a large scale	A supply chain application with benefits for more than one trading partner based on an open standard.





Interviews companies - number by category



All interviews took place in Western Europe and were carried out by an international team of business consultants, working in different countries and coordinated from the Netherlands.

In our opinion, these 50 organisations provide a good picture of the expected trends in the (Western) European retail market. It is important to note that no quantitative conclusions can be drawn for the whole retail market on the basis of these interviews. Firstly because the sample size is too small. Secondly, because the characteristics of these companies are not necessarily representative of the whole market. When approaching retail organisations, we focused on "early adopters" because these companies exert a great influence on the adoption of RFID.

The interviews with users of RFID technology (i.e. retailers, manufacturers, logistics service providers and RTI pool organisers) are based on a standard questionnaire. The starting point for the interviews was the identification of key business drivers and supply chain issues. From these topics we addressed specific RFID questions.

## 1.2 Structure of this document

We first look at the supply chain in the retail and CPG market and the use of returnable transport items, with an overview of the providers and the main processes. We also examine the current identification and tracking of returnable transport items. We continue with an analysis of the

technical aspects of RFID, concentrating on the issues that may delay or accelerate the large-scale implementation of RFID.

Next we examine the findings of the interviews, including the current status, plans and expectations of RFID for returnable transport items. The costs and benefits of RFID are analysed in the next section, based on a generic supply chain model. Finally, we look at the consequences of implementing RFID, and the impact this may have on the timing of RFID adoption.

The result of this analysis is summarised in a conclusion and a roadmap. This gives the timescale that we expect for RFID to be used in returnable transport items over the next few years. This roadmap forms the factual reply to the study question.

The appendices provide background information on specific subject areas.







## 2. Supply Chain Overview

As stated in the introduction, the study of RFID in returnable transport items is approached from a supply chain perspective. In this section we examine the interface in the supply chain between the product flow and the flow of returnable transport items. We identify the important developments in supply chain management, and the connection with RFID. Finally, theory is compared with practice as illustrated by the interviews.



## 2.1 The supply chain approach

As explained in the introduction, a supply chain viewpoint has been selected for the study of RFID for returnable transport items. We can define the supply chain approach as follows:

"All the management activities which are focussed on the chain, starting with the suppliers, then the manufacturers, logistics service providers and finally the retailers (or retail trade) are summarised under the term Supply chain Management or the broader Demand & Supply Chain Management".

In fact, this is not about the management of the chains, but the management of the flows of goods, information and money. RTI's are defined as a separate flow in this study, where RFID is a technology that supports this management.

The flow diagram below provides a schematic overview of the generic supply chain with the flow of goods (1) and the possible flows of returnable transport items (flows 2,3,4). These RTI flows are explained in more detail in the next section.

### 2.1.1 Supply Chain Management themes

It is important to know how the different links, or parties, in the chain interact with each other. Over the last few decades many changes have

stimulated thinking in terms of supply chains. The most important themes are examined below:

- Changing balance of power in the chains
- Chain reversal
- Pressure on stocks
- Increased legislation and regulation

#### *Changing balance of power in the chains*

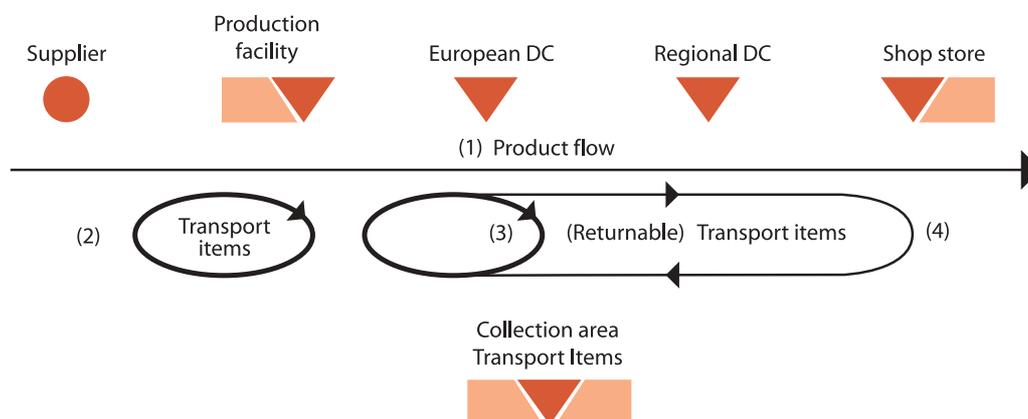
Over recent decades there has been a shift of power towards the end of the chain, largely caused by the consolidation among retailers. In many cases the retailers are now the first to adapt to changing market conditions and the first to initiate changes in the supply chain. We also expect retailers to drive RFID adoption.

#### *Chain reversal*

The traditional chain is supply driven. This so-called push-system arises from two basic concepts:

- emphasis on efficiency
- supply creates the demand

Changing consumer behaviour and the increased power of retailers put more and more pressure on fulfilling the demands of the consumer, creating a demand driven chain. The push-system is slowly replaced by a pull-system, with an emphasis on effectiveness. Speed, flexibility and reliability have to increase considerably. RFID may be an important tool in this respect, because it enables real-time data collection.



### *Pressure on stocks*

A significant motivation to deal with supply chain management is the ever-increasing pressure on stocks. The disadvantages of stocks are well known: the high costs and fact that products become obsolete. Changing consumer demands and fierce competition have increased the number of product changes and introductions. At the same time, the supply chain has become increasingly complex due to the growing numbers of suppliers, sales channels, outsourcing of production etc. This is combined with the stated higher requirements regarding reliability and flexibility. All in all, the pressure on stocks continues to increase.

In a direct sense, the use of RFID does not reduce stocks. However, real-time data collection enabled by RFID may lead to increased visibility and improved planning, reducing the uncertainty in the chain. This in turn leads to stock reductions.

### *Increased legislation and regulation*

In the last few decades, government regulations have increased considerably in the areas of environmental and quality requirements. This has led to an increase in required product information. In the field of food safety, visibility and traceability are of primary importance.

The General Food Law, officially effective in 2005, states that each supplier must know the origin of products from the previous link in the chain and the destination in the next link. In addition, retailers accept their own responsibilities regarding food safety and often impose additional traceability requirements on suppliers.

The consideration given to return logistics (packaging, whether reusable or not) has also increased due to environmental concerns.

The increased need for information throughout the chain and the desire for traceability of products mean that RFID is also a significant application from this point of view.

## **2.2 Availability of ICT tools**

With the increasing complexity of supply chain management, the use of different ICT tools has become much more important. Synchronisation, connectivity and visibility are key elements in these technologies.

Point of Sale (POS) systems are used by retailers and create market information. By scanning barcodes at the cash register, data is created so that frequent orders are possible. Automatic Ordering Systems determine how much needs to be ordered from distribution centres. These orders can be submitted using EDI or other methods.

Enterprise Resource Planning (ERP) packages are primarily used by manufacturers for internal business management. These packages can include warehousing and planning modules. Finally, logistics service providers make use of Warehouse Management Systems (WMS) and Transportation Management systems (TMS).

For communications between the trading partners in the supply chain, communications networks such as EDI are often used based on standards such as EANCOM and XML. However, traditional methods such as telephone, fax, and mail also remain widely used.

Barcoding fulfils an important role in the whole supply chain for identification purposes. However, the application is not always based on open EAN standards, so that logistics and retail partners often provide transport units with their own (barcode) labels.

## **2.3 Business pains arising from the interviews**

In the interviews we explicitly asked about the goals and challenges in the area of supply chain management. There appear to be differences between theory and practice, for example in the area of collaboration.

According to supply chain management theory, organisations in the chain work together on all



aspects of business management: marketing (promotions, introductions), logistics (physical distribution) as well as administrative tasks. In practice, it appears that this collaboration is often not established. Some of the reasons are listed here:

1. Many different chains can be identified in the CPG market as well as many changing parties in the chains.
2. Partners are very different in size, professionalism, culture, financial resources, level of automation, etc.
3. Partners take different positions within the chain, according to their own requirements, with their own functions, their own suppliers and clients. In short, partners cannot be easily compared.
4. The strategic importance of information is greater for one of the parties involved in an imperfect chain. In some cases, information means power over the chain.

In the interviews we explicitly asked about business pains. The pains are categorised as follows according to:

1. Product flow
  2. Information flow
  3. Return flows and logistics tools (RTI's)
1. The study shows that problems in the product flows - safety stocks, delivery reliability, and quality - are mostly encountered by the manufacturer. Reliability of deliveries is the issue for logistics service providers. The underlying cause is believed to be a lack of transparency in the chain, due to insufficient and late information, especially with product introductions and promotions.
  2. Problems with information flows, including administration and communications, are experienced more often by retailers. Synchronisation of source data is a problem in the chain. This leads to miscommunication in ordering, logistics and billing processes. Burdensome rectification measures are the result.
  3. The RTI's are less of a problem for the retailer than for the manufacturers and pool

managers. The latter have the specific problems of asset management. Manufacturers need durable and effective (standardised) transport items with short return times in conjunction with deposits. The exception are those retailers who supply to franchisees. They need crates, pallets and roll containers to be properly registered, otherwise they pay for the loss or lose their deposit.

## 2.4 Summary

- Shifts in the market have created a great challenge for logistics.
- Retailers take a dominant position in the supply chain and also have a controlling role in the introduction of RFID.
- Cooperation in the supply chain is insufficient, according to the interviews.
- Information problems are often the basis for logistics problems.
- ICT solutions such as barcoding, integration of systems, are often insufficiently exploited.



### 3. Returnable transport items

In this section, we analyse the various types of RTI's, as well as their use in the supply chain and current identification and tracking options. This enables us to examine how RFID can be used in returnable transport items.



### 3.1 Overview of existing RTI's

The International Council for Reusable Transport Items (IC-RTI), which operates under the umbrella of ECR Europe and is supported by EAN International, gives the following definition of Returnable Transport Items:

"RTI's include: any means of gathering together goods, transporting them, storing them, to protect them within chains, which is reusable, such as pallets, reusable packaging such as crates, containers, roll containers".

For the purpose of this study, we will use this definition. The term RTI is usually used for secondary and tertiary packaging. However, it is also sometimes used for consumer packaging, such as beer bottles. Consumer packaging does not fall within the scope of this study. The pic-

tures below give a few examples of RTI's (Source: Container Centralen).

On a high-level, two different ways of using RTI can be identified:

- Direct exchange: RTI which are used internally within an organisation or which are used bilaterally between two organisations. An example of this is the roll containers that a retailer uses between the retailer distribution centre and the stores for delivering goods.
- Pool organisation management: RTI that are managed by a pool organisation, such as pallets and reusable crates.

#### 3.1.1 Process description

We provide a brief overview of the way RTI's are used in the retail supply chain, based on the IC-



Roll container



Crate



Dolly

Rolly



Pallets

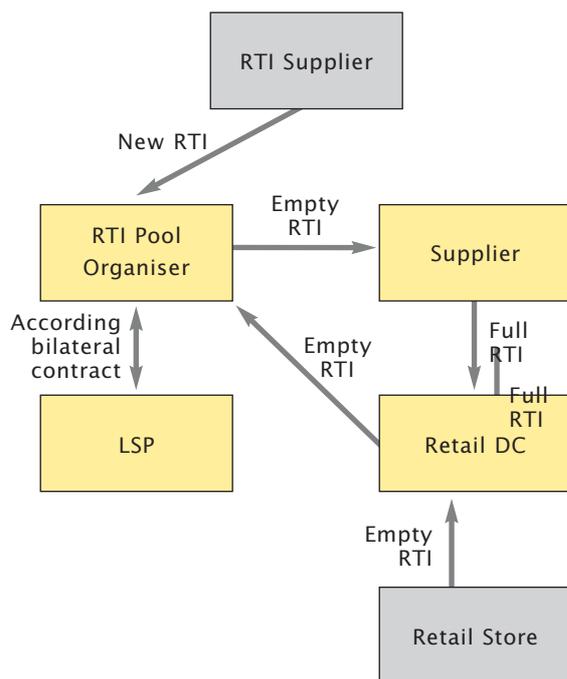


Minitainer

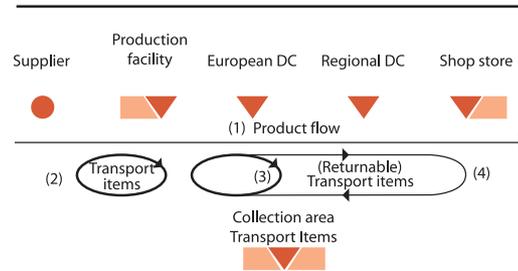
RTI description. In this process we identify the following parties:

- RTI Suppliers: produce the RTI and sell the RTI to the Pool Organiser.
- RTI Pool Organiser: manages an RTI pool and makes the RTI available to the supply chain. Examples include CHEP, Euro Pool System, Container Centralen and many others.
- Supplier: uses RTI in the distribution of his goods. Suppliers fill empty RTI with goods and hand over filled RTI to retailers. A supplier can be a packer, farmer, brand manufacturer, distribution centre, consolidation point etc.
- Retailers: receive RTI from suppliers and make the RTI available for collection. RTI Receivers can be retailers, distribution centres etc.
- Logistics service providers (LSP): may collect RTI from retailers and might offer additional services, such as cleaning and repair of RTI. May also operate as a RTI pool organiser.

The following diagram gives a generic view of the physical flow of RTI through the supply chain:



The generic supply chain



The exact flow of the returnable transport items through the whole supply chain can naturally differ from this illustration and depends on the specific application. In the previous section, different flows of these transport items were introduced in the diagram above.

*Pallets:* used on a large scale in the European retail market, often in pallet pools. Typically the pallets are not delivered to the retail store, because store deliveries are based on individual cases or crates. Pallet flows are represented by flow 3 on the diagram above.

*Crates and containers:* used in European retail primarily for fresh products such as fruit, vegetables, dairy products and meat. For these products, the crates are used throughout the whole chain. For example, a tomato grower fills a crate with tomatoes in his greenhouse, from where the crate is transported, via the market, to a retailer DC and finally to the stores. These flows are represented by flow 4.

*Roll containers / Dollies / Rollies:* often used for a retailer's internal processes, such as to transport cases of products from the retailer DC to the store.

### 3.2 Managing RTI pools

RTI pool organisers manage the RTI pool with very little insight, because the visibility of the RTI flow and the transparency of the chain are very limited. The lack of insight applies to all parties, with both manufacturers and retailers focusing on the flow of goods. RTI's are of much lower importance, and thus value, to retailers and manufacturers than the products. If RTI pool organisers could better track the individu-





al RTI they would be able to achieve significant benefits, for example by reducing safety stocks.

### 3.3 Current use of identification and tracking

The most well known barcode for consumers is known as the EAN-13 barcode, which is used on consumer products to identify the product type. Other standards are used for the identification of RTI's. At the moment, EAN-UCC uses various standards to support the identification and tracking of RTI in the retail supply chain. These standards are based on the Application Identifier standard for data specification and the EAN-128 symbol technology to convey this information in barcodes. An EAN-128 barcode can contain several blocks of data that are identified using an Application Identifier. There are a number of variants, and the following are of interest to us:

1. Identification of the RTI: Global Returnable Asset Identifier.

The Global Returnable Asset Identifier (GRAI) can be used to identify and track the RTI. The RTI have to be manually scanned or manually recorded at each transfer point to enable them to be tracked. This incurs labour costs that have to be justified. The pool manager has a direct demand on some partners in the chain by means of deposits and not on others.

2. Tracking of the products on the RTI: Serial Shipment Container Code.

The products on the RTI can be tracked in the supply chain via the Serial Shipment Container Code (SSCC). This code identifies a specific shipment at pallet level and is therefore not limited to RTI but is equally applicable to single use packaging. If the shipment is a homogenous pallet, additional information can be included in the EAN128 symbol, such as the item code, batch number, best before date and country of origin.

Both variants of the EAN-UCC coding are not (yet) used on a large scale. This demonstrates that companies are currently not using all possibilities of tracking RTI and products in the supply chain.

### 3.4 Summary

- A large variety of RTI's are used in the CPG & retail supply chain in terms of material, dimensions, weight, whether or not they have wheels.
- Management, recording and administration is complex and labour intensive, because the market is not transparent, RTI's are used throughout the whole chain, they change owners and the view of the chain is often limited.
- Identification and recording of RTI's using bar-coding has limited application, primarily for the reasons mentioned above.
- As a result, tracking & tracing products via RTI registration does not occur on a large scale.



## 4. RFID technology and issues

A great deal is currently being written and said about the opportunities and problems of RFID technology. We will analyse this topic in depth in this section. We give an overview of RFID technology, its integration with existing software applications and the most important differences from barcodes. We also analyse the potential issues that may impact RFID adoption in the retail supply chain, including standardisation and environmental factors.



## 4.1 The Basics of RFID

RFID technology has been around for many years and is used in applications such as access control, animal tagging and electronic toll payment. The technology consists of two elements that communicate via radio waves: a tag (or transponder) and a reader.

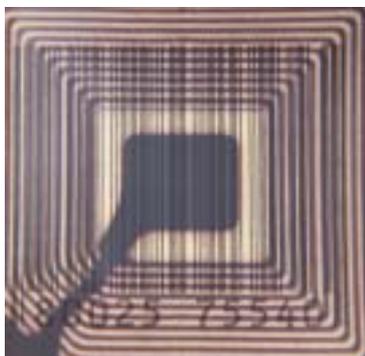
### 4.1.1 Tags

An RFID tag consists of a microchip connected to an antenna. The microchip contains a certain amount of data. Different types of tags are available, which are tailored to different purposes.

- Energy supply: Active vs. passive tags.  
Active RFID tags contain a battery to provide the microchip with power. This type of tag can send a signal independently to a reader. Passive tags do not have a battery. This type of tag is powered indirectly via the electromagnetic radio waves from the reader. Active tags are often used to track high value goods over a distance of up to 300 meters. However, these tags are expensive compared to passive tags. Passive tags have a limited read range and do not require maintenance.

In the rest of this study, we concentrate on passive tags, because they are likely to be used in returnable transport items and in other supply chain applications.

- Changes to the data: Read-only, Read-Write and WORM tags RFID tags can be of Read-Write, Read-Only or WORM (Write-Once, Read Many) type. The data on Read-Write tags can



be changed or totally overwritten by any reader. These tags are clearly more expensive than Read-Only tags, which makes them inappropriate for tracking low value products. Read-Only tags are written with a code by the tag manufacturer that can never be changed. WORM tags can be rewritten once by a reader. This makes a WORM tag very suited for establishing a worldwide, unique product code, which can be set on the tag locally (e.g. in a factory). It is suitable for placing on disposable packaging. Read-Write tags, however, are possibly more appropriate for use on pallets/crates that are reused, so that the tag can be rewritten with information such as a shipment number.

#### *Cost of the tag*

The cost of RFID tags has fallen significantly in recent years, which is one of the reasons for the current interest in RFID. The business case for many applications is highly dependent on the price of the tag. However, this aspect is less important for returnable transport items, because the tags can be used for much longer, possibly even for years.

The price of a passive tag is currently (beginning of 2004) between 0,20€ and 1€. A further drop in tag prices will depend on progress in more efficient assembly machines and demand for higher volumes.

Analyses (including by the Auto-ID Center) show that with a volume of 30 billion tags per year, the price of a simple passive tag could, in principle, fall to 0,05€. At the moment, a significant increase in demand is expected, based on mandates from organisations like Wal-Mart, Target, the Department of Defense and the support for RFID from the Food and Drug Administration (FDA). According to these plans, the expectation that a 0,05€ tag will be available in 2007-2008 is realistic. Until that time, we anticipate prices to go down gradually.

### 4.1.2 Radio Waves

Tags communicate with the reader via radio waves, which are part of the electromagnetic spectrum. For RFID technology using passive



tags, the frequencies below are generally used:

- Low frequency (LF) - These tags work at a frequency of around 125 kHz and have a reading range of less than 50 cm. The reading speed is relatively low and the tags are relatively insensitive to interference. Tags in this frequency range have already been used for years in applications such as access control and animal tracking.
- High frequency (HF) - Operate worldwide at 13.56 MHz and can be read at distances of around one metre, but tags use more energy than low frequency tags. Existing uses include tracking books in libraries and baggage at airports. ISO 15693 provides a worldwide standard for this frequency.
- Ultra-High frequency (UHF) These tags work at a range between 860 and 930 MHz and can be read from further away and at higher speed than HF tags. This makes this frequency the most appropriate for supply chain applications, such as tracking pallets and cases. This frequency is less appropriate for an environment with a lot of moisture and also uses more energy than HF technology.

The table below shows the characteristics of the different frequencies, such as reading range and the number of tags that can be read per second by a single reader. It is important to note that these are only indications, because each situation in practice can lead to a different performance.

#### 4.1.3 The Reader

RFID readers can communicate with tags in different ways. The most commonly used method for reading passive tags at close range is called

"inductive coupling". The reader's antenna creates a magnetic field in the tag's antenna, which provides the tag with energy. The tag can then send its data back to the reader.

#### *Rapid and affordable readers*

At the moment, readers cost 500€ or more. Most types of readers can only work with individual frequencies. In the long term, we anticipate that rapid readers will be developed that can read tags at different frequencies. This would avoid the need to purchase a separate reader for each frequency.

For the use of RFID in RTI, the cost of the readers would constitute a large part of the overall costs. Readers must be affordable, because companies would have to buy a relatively large number of readers to be able to cover the whole operational area.

## 4.2 Software Integration

Integration of the RFID data with existing software applications is an important aspect to the introduction of RFID technology. The data collected by the RFID readers needs to create value, such as more supply chain visibility or better planning.

The fact that a large scale implementation of RFID in the retail supply chain may lead to an explosion of collected data is important in this respect. It creates a need for software to bridge the gap between the RFID data coming from the RFID readers and the existing software

Characteristics of the different frequencies			
Frequency	Short Descr.	Read Range (Meters)	Data Speed (Tags/ Sec)
125 - 134 kHz	LF	0.45	1 - 10
13.56 MHz	HF	< 1	10 - 40
868 - 870, 902 - 928 MHz	UHF	2 - 5	10 - 50





applications. It is not surprising that the major middleware suppliers, Enterprise Resource Planning (ERP) and Warehouse Management System vendors have announced plans with regard to RFID.

Appendix 2 gives an overview per software supplier, showing the name of their software solution, its functionality and an indication of when the solution is likely to be available. This clearly shows that the market for RFID integration software is relatively immature.

The costs for the integration of RFID with the

existing business applications is a significant part of the total RFID implementation costs. We estimate the cost for off-the-shelf software for each physical location at between 75,000 and 125,000€ and that is without the actual integration costs. The price level of the software will possibly fall, once several implementations have been carried out and competition increases between the various software suppliers.

The next few years we will see more and more RFID middleware in the supply chain. Furthermore, this middleware will be more and more integrated with wireless communication solutions, such as GSM and GPS for real-time tracking and tracing. We believe that RFID middleware will become a standard part of all large enterprise applications (ERP, WMS) in the future. At the moment, however, this software is still relatively immature.

### 4.3 RFID versus Barcodes

As mentioned earlier, RFID in the retail supply chain can be used as an alternative to barcodes to identify and track objects. RFID has very different properties, which are summarised in the following table:

Barcodes	RFID tags
Can only be read individually	Faster reading, as they can be read simultaneously.
Must be visible to be read	No line of sight required.
Cannot be read if they are dirty or damaged	Can deal with rough and dirty environments better, because tags can be integrated into the packaging materials.
Are usually read manually and thus incur labour costs. Automated scanning demands standardisation of barcode location.	Are read automatically so no labour costs.
Information cannot be changed (new label required) Limited quantity of information	Information can be changed, if desired, for example temperature fluctuations. Quantity of information depends on application.



With RFID it is possible to identify and track objects without time delays, without human intervention and thus without variable costs. In principle, RFID offers great added value to the logistics chain, because products can be tracked more easily and at lower cost. This means that the speed and reliability of the logistics process can be optimised better with RFID than with barcodes.

#### 4.4 Implementation issues

A number of issues need to be addressed in the implementation of RFID because they may influence the widespread adoption of RFID in the European market. Based on interviews and desk research, we look at the most important issues in greater depth, specifically:

1. Standardisation
2. European legislation concerning UHF
3. Physical characteristics of RFID
4. Maturity of available technology
5. Lack of knowledge and experience

##### 1. Standardisation

Standardisation is essential for the use of RFID in open supply chain applications, both with regard to the content of the tag and the way in which the tag and the reader communicate (the so-called air interface). The EPC standard is important in this respect, as well as its relationship to existing ISO standards.



The Auto-ID Center was set up in 1999 at MIT in Boston, USA as a joint initiative from companies such as Gillette and Procter & Gamble. The vision of

the Auto-ID Center was targeted right from the start at a world in which every product could be uniquely identified by an RFID tag and in which all additional information could be stored in a worldwide network. In the following years, this initiative achieved

broad support from the retail world, which led to a worldwide group of more than 100 sponsors, including Wal-Mart, Metro, Ahold and Tesco. This created the basis for a de-facto RFID standard in the retail world, which was not based on the existing ISO standards. This was shaped further by the announcement from Wal-Mart in June 2003 that all suppliers would have to supply pallets and boxes with RFID tags using UHF technology and the EPC (Electronic Product Code) standard developed by the Auto-ID Center.

In the autumn of 2003, the work of the Auto-ID Center led to the publication of



the EPC Network standard version 1.0, described in more detail in Appendix 1. At the same time, EPCglobal was set up, a joint venture between EAN International and the Uniform Code Council (UCC). The purpose of EPCglobal is to further develop and implement the EPC standards worldwide. EPCglobal operates as an independent non-profit organisation. At the moment, EPCglobal is still operating in start-up mode. It is likely to be a few more months before EPCglobal is fully operational, partly because the implementation has to take place in each individual national organisation within EAN International. Additionally, the work of EPCglobal has recently been somewhat delayed by issues surrounding the intellectual property (IP) policy. The majority of these problems appear to have been resolved in the meantime.

At the moment (early 2004), there is no definitive standard supported by both EPCglobal and ISO. There is significant pressure from the retail industry to solve this problem as quickly as possible. The answer will have to be found in the EPC Class 1 Generation 2 standard, which will then also be taken over by ISO. Based on current information, we anticipate that the standardisation issue will be resolved by the end of 2004.





It is also clear that the early adopters in the retail industry fully support the EPC standard and that future EPC standards are likely to be forward compatible with the current EPC standard, in view of its current implementation by users such as Wal-Mart.

## 2. *European legislation*

The use of Low frequency and High frequency technology has become well standardised and harmonised around the world. The situation is much more complex for UHF technology. In the United States, this technology is already widely used, but in Europe the use of UHF has been limited due to the existing legislation from the European Union. This legislation limits the reading range and speed, primarily because the power output of the reader is limited to 0.5 Watts. In Europe, the desire to place the use of UHF on an equal footing to the USA is generally recognised. This is why the European Telecommunication Standards Institute (ETSI) has developed a proposal, which suggests increasing the permitted power output to 2 Watts.

At the moment, this proposal has been submitted to the various member states for approval. On the basis of discussions with the various parties involved, we anticipate that this proposal will be approved by the end of 2004. This is very important for the large-scale use of RFID in the European retail supply chain. In the mean time, companies will need to request a site license if they wish to use UHF technology based on the American standards.

Apart from this, the United States and Europe will continue to use different frequencies in the UHF range in the future. This can be overcome relatively simply in the RFID tags and readers.

## 3. *Physical characteristics of RFID technology*

When implementing RFID technology we need to take into account a number of physical

characteristics that may lead to possible problems.

- **Reader interference and collision**  
A possible problem with RFID is the overlap in signal from different readers. This problem is known as reader collision. All RFID standards contain a solution for dealing with this problem, but additional functionality is often required in the application software.
- **Tag collision**  
Another problem arises when too many RFID tags come within range of an RFID reader at the same time, and simultaneously send a signal to the reader. This can confuse the RFID reader, which is known as tag collision. This problem primarily arises with active tags, which send a signal themselves, independent from the reader. Here too, the RFID standards offer different solutions to the problem.
- **The environment in which RFID is used**  
A number of different environmental factors must be taken into account when designing an RFID system. Objects in the environs of the readers and the tags affect both high and low frequencies. Higher frequencies, for example, are easily absorbed by water, which means that these frequencies are less appropriate for products containing a lot of water. At the other end of the scale, lower frequencies are more strongly affected by metal objects. In most cases, good design can produce a solution to these problems.

These factors also play a major role in the fitting of RFID tags to returnable transport items. This is often a practical challenge, for example on metal roll containers or wooden pallets.

Due to these physical characteristics of RFID technology, the use of RFID must be analysed for each specific environment. Time and money will be required to implement the technology.

- **Maturity of available technology**

The interest in RFID for supply chain applications is relatively new and no large-scale implementations have yet been carried out. Products are often not completely faultless, particularly for UHF technology in Europe. As a consequence, it often takes considerable time to install the RFID hardware. This problem is likely to reduce rapidly thanks to the large-scale implementation by organisations such as Wal-Mart.

In view of the anticipated progress in standardisation and European legislation, we anticipate that reliable UHF technology for the European market will be available in 2005. In 2004, companies will have to work with UHF products that meet American standards (for which a site license can be requested), or with early versions of new products designed for the European market.

- **Lack of knowledge and experience**

In comparison with barcodes, RFID is still a complex technology in which little experience has been gained. Knowledge of the technology is relatively low in most organisations.

Most of the knowledge of the installation of RFID technology in the supply chain currently lies with small organisations that have been involved in the first supply chain projects. Large-scale implementation on a European level will demand the support of larger international technology companies in the field of hardware installation.

- One frequency doesn't fit all. UHF technology is the most appropriate for supply chain applications due to the read range and speed. The question remains whether this technology can be used in environments with a lot of liquid or for products containing a lot of water.
- The cost of RFID tags will drop further in the next few years due to an anticipated increase in volume. A price for a passive WORM (write-once read many) tag of 0,05€ in 2007-2008 is possible. A further drop in the price of RFID readers is also to be expected, although this is harder to predict.
- Software to integrate RFID with business applications is currently immature. At the moment, significant investments are being made by software vendors. In a few years, this will be a standard part of ERP, WMS and supply chain management applications.
- Standardisation is not yet finalised, despite the progress with the EPC standard.
- European legislation currently limits the use of UHF technology, which means that the products available are relatively undeveloped.
- We anticipate that the issues regarding standardisation and European legislation will be resolved by the end of 2004.
- Consequently, from 2005 reliable UHF products that meet these standards will be available on the European market.
- Because of the physical characteristics of RFID technology and the limited knowledge and experience with this technology, RFID implementations in the near future will require considerable time and effort.

## 4.5 Conclusions

- Using RFID tags, it is possible to identify and track objects without time delays, without human intervention and thus without variable costs. With RFID, the logistics process can therefore be better optimised than with the barcode.





## 5. RFID and Returnable Transport Items: Status and expectations

During the interviews we discussed the expectations and plans regarding the use of RFID in returnable transport items in much depth. In this section the results of these interviews are analysed.



As stated in the introduction to this report, the companies interviewed do not necessarily form a representative sample of the whole retail market. It is therefore not immediately possible to draw conclusions for the whole retail market. However, the analysis does provide sufficient insight to enable us to answer this research question.

We start with an overview of the possible applications of RFID in returnable transport items and examine three case studies.

### 5.1 Possible applications of RFID in RTI

In the application of RFID in returnable transport items, there is a significant difference between asset management and tracking the flow of goods. These two applications are explained below.

1. Asset management, by identification of RTI with RFID tags

As stated earlier, RTI pool organisers currently manage the RTI pool with a very limited visibility, which leads to large safety stocks. With RFID technology, the management of the pool can be significantly improved, if all RTI are fitted with RFID that uniquely identifies the item. However, it is necessary for the RTI Pool organisers to have access to the data gathered in the supply chain. This means that retailers and suppliers need to install RFID readers to track the RTI and to make the resulting data available to the RTI pool organiser.

2. Tracking products in the supply chain

The primary interest of retailers and food manufacturers is in tracking the flow of goods within the supply chain. Of secondary interest is the tracking of specific returnable transport items. The tracking of shipments, i.e. the goods on or in the returnable transport items, is the most important application of RFID in RTI for retailers.

The table below briefly summarises these applications:

Application	Advantages for	Business advantages	Options
Identification of individual RTI	RTI Pool organiser	More efficient asset management of the RTI pool	WORM RFID tag permanently attached to RTI
Tracking the flow of goods on or in RTI	Retailer, manufacturer	Better supply chain visibility More efficient processes in RTI handling	Various options, such as read / write tag in RTI, or WORM RFID tag in RTI and SSCC barcode, or WORM RFID tag and SSCC in database





## 5.2 RTI versus disposable packaging

Stating that retailers are primarily interested in tracking the flow of goods, raises the question whether the difference between disposable and reusable packaging is relevant.

This study focuses on returnable transport items because many anticipate that these will be the first products to be fitted with RFID tags. Because the tags can be reused, the cost of the tag are less relevant. During various interviews, the difference between disposable and reusable packaging was discussed.

Some companies anticipate that disposable packaging will be fitted with RFID tags before RTI. On RTI the tags will be reused for a number of years, requiring a future proof standard. Additionally, migration is time consuming and laborious for existing RTI pools. Finally, it is more or less impossible to equip 100 % of the assets in an existing RTI pool with tags, which means that there will always be exceptions.

On the other side one can argue that the costs of the tag are relatively much higher for disposable packaging. This makes the business case much harder, especially the breakdown of costs and benefits in the chain.

However, the most important point to realise is that all companies in the supply chain use both reusable and disposable packaging. They are used in the same chains and in the end will also use the same infrastructure. An RFID tag on a crate or roll container will be read by the same reader in the distribution centre as the tag in the smart label on a cardboard box. From the retailer's perspective, it does not really matter whether the packaging is single use or reusable, the important thing is tracking the products in the chain.

In the remainder of this section, when we analyse the answers from the companies interviewed about the use of RFID in the supply chain, we will not draw any explicit distinction between the use of RFID on reusable or disposable packaging.



### 5.3 Case studies

Various companies already have experience with RFID in RTI. Some examples are discussed here, because they provide a good example of the possibilities of RFID and its current status in RTI.

	Hoogvliet	Hays Logistics	CHEP
Items tagged	Roll containers	Crates	Pallets
Frequency	LF	HF	UHF
Read/write	Read-only	Read/write	Read-only (EPC code)
Open/Closed system	Closed	Open	Open
Aim	Better tracking of roll containers in the distribution process in the distribution centre, reduction in handling errors.	Better tracking of crates throughout the whole chain, including additional information on food safety.	Better asset management of pallets, and development of new services for customers.
Status	All roll containers fitted with RFID tags. Checking of roll containers with truck implemented.	Various trials carried out. Definitive trial in Spring 2004.	Various pilots carried out. Now awaiting action in the retail market.
Expectations for the future	Further development of software for optimisation of the distribution process.	Depending on acceptance in the chain, where standardisation and frequency (HF) are an issue.	Unclear. Most likely CHEP will add RFID tags to part of the pool, and offer a separate service.

These case studies are described in more detail in appendix 4. It is important to see that practical experience has already been gained with RFID in roll containers, crates and pallets. Furthermore, the technologies chosen are very different, showing that it is much simpler to implement a closed loop application like Hoogvliet than an open loop application like CHEP.

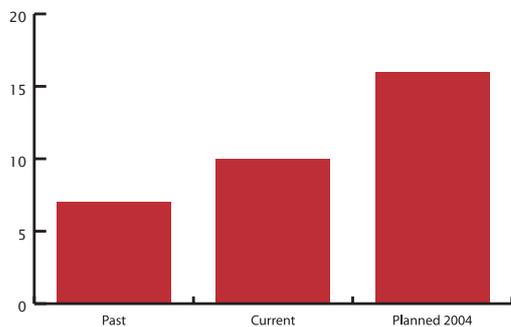
In the remainder of this section we analyse the interviews with retailers, food manufacturers, logistics service providers and RTI pool organisers. We look at the experience these companies have gained with RFID, the strategic importance they place on RFID and the anticipated use of RFID in their own organisations. Finally, we look specifically at the early adopters, as they play a decisive role in the further introduction of RFID.



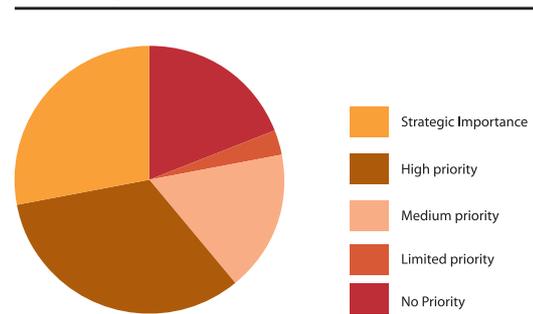
## 5.4 RFID Experience

Our study shows that the number of pilots and implementations of RFID is increasing significantly, as shown in the diagram below. All RTI pool organisers involved in this study are running pilots or are going to do so. The majority of the other pilots involve food retailers. Non-food retailers, food suppliers and logistics service providers stay behind.

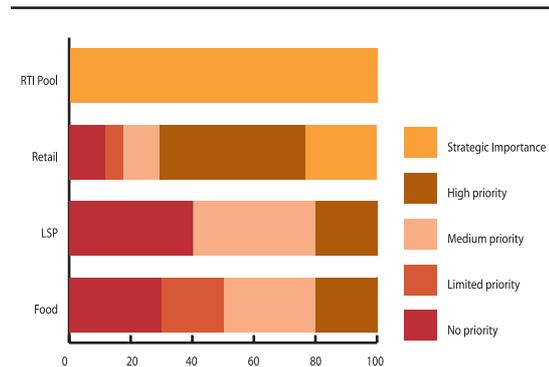
Organisations with RFID pilots and implementations



RFID on CEO agenda?



Policy interest in RFID



## 5.5 Strategic importance of RFID

To be able to predict when RFID will be used on a large scale, we examined what strategic importance organisations place on RFID. We examined this subject through four questions, which are analysed below:

1. How high is RFID on the CEO's agenda
2. How is RFID embedded in the organisation
3. What is the level of knowledge of RFID
4. Has a cost / benefit analysis already been carried out

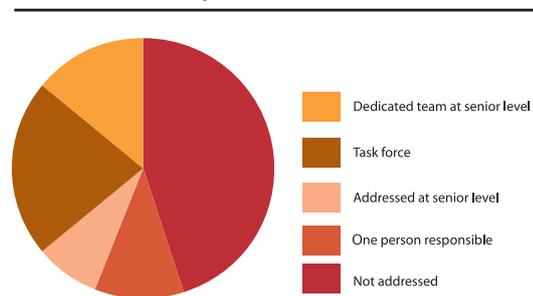
### How high is RFID on the CEO's agenda

The interviews show that 60 % of the companies give RFID high priority or top priority. There are differences between the different types of companies: RFID is a top priority for all RTI pool organisers, and RFID is higher on the agenda for retailers than for food suppliers and logistics service providers, as shown by the graphics below.

### How is RFID embedded in the organisation

RFID is not embedded in almost half of the companies (see graphic below). However, companies that have embedded RFID in the organisation have primarily done this at a strategic level, i.e. directly with the senior managers or staff organisations which report directly to senior management.

Is RFID embedded in the organization?

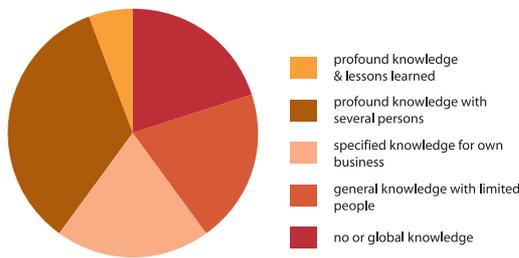




*What is the level of knowledge of RFID*

With regard to the knowledge of RFID within the organisations, a very positive picture was drawn, as shown from the overview below. However, it should be noted here that in many organisations, this knowledge is only held by a small group of people. This often concerns the senior managers and the people who are dedicated to RFID. Most of the companies interviewed stated that middle management still has only very limited knowledge of RFID, but this is not yet a problem with the market at its current stage. These middle managers, especially in operations, are sometimes sceptical about RFID technology.

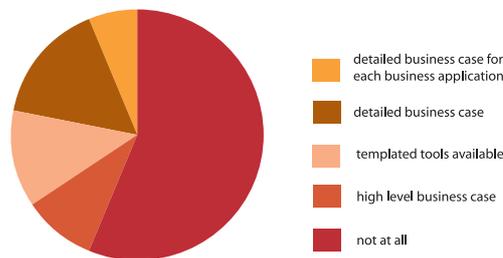
What is the level of RFID knowledge in the organisation?



*Has a cost/benefit analysis already been carried out*

Although knowledge within the organisation is generally considered to be high, only a few organisations have actually carried out a detailed cost/benefit analysis for the implementation of RFID in their own organisations. We do not have any clear explanation for this.

Have you made a cost/benefit analysis of RFID adoption?

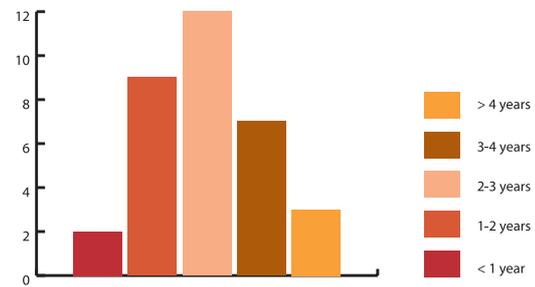


In summary, we conclude that senior management has often a strong interest in RFID, but that there is a significant difference in the priority actually given to this subject within the organisations.

**5.6 Anticipated use of RFID in each organisation.**

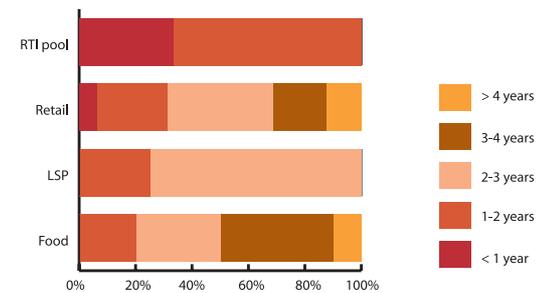
We also asked companies when they expect RFID to be implemented on a large scale in their organisation. The results of this question are shown in the following diagram:

Expected timeframe for RFID implementation in the organisation



Once more, the RTI pool organisers are ahead in the implementation of RFID in their own organisations; food suppliers and logistics service providers are behind.

Breakdown of RFID implementation in the organisation



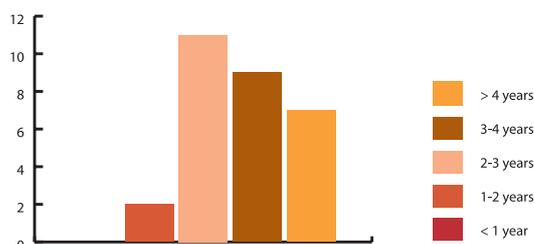
If we look specifically at retailers, we have drawn a distinction between food (or grocery) retailers and non-food retailers. This shows food retailers are ahead of non-food retailers.



This corresponds to the introduction of barcodes, which was also implemented by food retailers before the non-food retailers.

If we look at expectations regarding the implementation of RFID in the market as a whole, we see the following picture. It is clear that the companies we interviewed expect that on average they will implement RFID before the rest of the market.

Expected time frame for RFID adoption in the retail industry



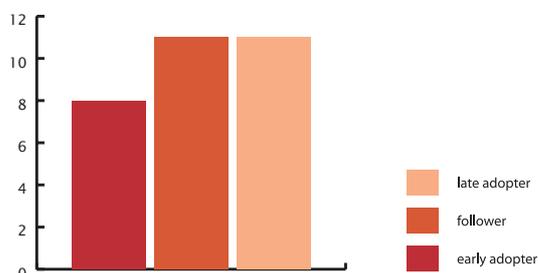
We also conclude that UK retailers are ahead. All of the UK retailers interviewed anticipate implementing RFID in their own organisations within two years.

## 5.7 Analysis of the early adopters

The early adopters play an important role and have the most concrete plans and demands for RFID implementation. That is why we analyse this group in more detail.

Eleven companies expect to implement RFID on a large scale within two years. Of these, eight

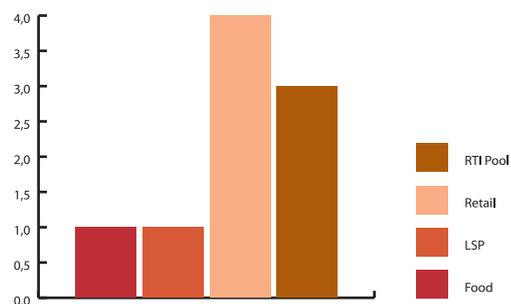
RFID Adoption Curve



companies consider themselves to be early adopters of RFID. These eight companies consist of six retailers and two RTI pool organisers. Once again, it is very clear that food suppliers and logistics services providers are primarily followers and late adopters.

The companies that want to implement RFID within two years, are divided between the various types as follows:

Distribution of organizations implementing RFID in less than 2 years



### The use of RFID:

Various RTI Pool organisers plan to have RFID tags moulded into new products, specifically in plastic crates. In this case, the cost of fitting the tags is minimal and the cost of the tag is relatively low as part of the total cost price. In addition, migration is not an issue in the event of new products. A new product is therefore an ideal starting point.

The applications are somewhat broader for retailers. All retailers are interested in tracking products at case level to the store. The use of returnable crates in this process varies greatly by retailer, but retailers who make significant use of them have a strong interest in tagging these crates.

The (physical) tagging of pallets is not a high priority for these retailers, because pallets are generally used only until the products reach the retailer's distribution centre, and not in the distribution process to the stores. Large retailers made the following comments on the tagging of pallets:



*"We do not see benefits of pallet tagging because only two items in our supply chain are shipped on pallets - the rest is re-packed into reusable transport items. Therefore there is no benefit for us in tagging pallets. We will go straight to the case level, if we can see the case we can see the pallet."*

*"Pallets do not seem like a logical item to tag. The items above the pallet are of interest. Tracking pallets may be interesting in terms of a shipment i.e. the number of pallets in the shipment and where they are destined. This is the only instance we can see for tagging at pallet level and this can be easily done with a barcode, as the cost is minimal. So we have no business case for pallet tagging."*

*"The biggest opportunity is at case level. Pallet tagging is irrelevant, because if we can see the case we can see the pallet."*

We anticipate that retailers who start to demand RFID tags from suppliers will show an interest in tagging pallets in time, although they do not care about the pallet itself, but the shipment. Consequently, it will be possible to use a smart label with RFID, containing a Serial Shipping Container Code, which is placed on the pallet (and is thus only used once). The unique identification of pallets from the point of view of better pallet management is of no value to these retailers.

#### *Preference of standards and frequency*

In general, the early adopters prefer the EPC standard and the use of UHF technology. However, we need to identify a few nuances here. With regard to the EPC standard, these companies recognise that this is not yet finalized, but the general expectation is that this will happen before the end of 2004. This does not include the network component of the EPC standard. The EPC Network is still very much in its infancy and will not be available to companies for some time yet.

With regard to frequency, the preference of UHF is understandable, especially due to the greater read range and speed of reading. Some companies, which have already started to use RFID on reusable assets, have opted for HF (13.56 MHz) technology. There is also the question of whether UHF can actually be used to track all products. There are still important questions, especially concerning products containing a lot of water.

#### *The drivers of the early adopters*

The drivers of the early adopters concur strongly with the description in the book "Crossing the chasm" by Geoffrey Moore about the adoption of new technologies. In general, these visionary companies, or at least the visionary people within these companies, regard RFID as a possible breakthrough in supply chain management rather than an incremental improvement. Kevin Ashton, the former Executive Director of the Auto-ID Center is an outstanding example of a visionary motivated by the realisation of a "dream". This dream consists of a business goal which can provide a huge step forwards in the way organisations work. These visionaries are also willing to promote this dream against the natural resistance that exists and to work with technology that is immature.

In the case of RFID, the visionary retailers certainly have a dream, in which RFID will be used at item level in the end, and cash registers, for example, will no longer be necessary and customers will be charged automatically as they leave the store, without long queues at the registers. One retailer we interviewed tells us of his "dream":

*"When we are in a position to implement item level tagging six months earlier than our competitors, then that will give us an unprecedented increase in market share, meaning that all investments would be repaid directly many times over."*

The early adopters share a strong belief that additional advantages of RFID will become clear



once the RFID infrastructure is implemented. Comparisons with the first car were made in various interviews, illustrated in the picture below. It is clear that this car shows great similarities with its predecessor: the carriage. In brief, the first car was designed as a "carriage with an engine", and it was only after the car had been designed that people realised that a whole range of other designs were possible. The analogy with the barcode as the carriage is clear: only when RFID has been implemented will the possibilities for further optimising the supply chain become clear. A VP Supply Chain of a large CPG manufacturer phrased this as follows:

*"Once we have implemented RFID in our supply chain, additional benefits will become clear. Perhaps it will become clear that we can optimise our supply chain by closing a whole distribution centre, but at the moment we cannot predict that yet."*

VP Supply Chain, CPG manufacturer



The early adopters must have the financial resources to realize their vision. It is no coincidence that companies such as Wal-Mart, Procter & Gamble, Tesco and Metro fall into this category.

#### *The inhibitors of the early adopters*

Although the early adopters are motivated by a strong long-term vision, this does not mean that

they are not curbed by various factors. In the first place, there is the natural resistance to change, which still exists in these companies. The visionary managers need to overcome quite considerable scepticism, especially in operational management. These companies often already have relatively efficient logistics processes, resulting in many people failing to feel that RFID solves a specific problem and that many things can also be done with barcodes. In order to avoid this problem, early adopters often focus on identifying "quick wins", applications of RFID in their own organisation for which a business case can be developed in the short term.

In addition to these internal challenges, the early adopters also have to deal with standardisation and technical issues described earlier. However, the early adopters are willing to work with technology that is not yet fully mature.

#### *Consequences for followers*

The followers in the market have a more pragmatic outlook to RFID. They are interested in an increase in productivity from their existing operations and the migration needs to be as simple as possible. They want evolution, not revolution. Above all, they do not want to solve the problems inherent to immature technologies. When these companies implement the technology, the products will have to be reliable and easy to integrate with existing applications.

The interviews reveal a significant difference in knowledge and experience between the early adopters and the followers about the possibilities and long-term impact of RFID. Like barcodes, RFID is a supply chain subject, which means that companies impact each other. When the early adopters implement RFID, this will create a snowball effect with major consequences for the other retailers, food suppliers and logistics service providers. The adoption of RFID will be an irreversible process when the early adopter start implementation, similar to the introduction of the barcode in the seventies.

It is therefore very important for the followers to gain knowledge and experience with RFID



technology as soon as possible. This will give these companies an insight into the possibilities and limitations of the technology, as well as the business advantages that may be achieved in the long run.

## 5.8 Conclusions

- There are two different application of RFID in returnable transport items: (1) asset management of the pool of returnable transport items and (2) tracking the flow of goods on or in the returnable transport items
- For RTI asset management, the direct advantage is experienced by the RTI pool organiser who can manage the pool more efficiently. However, this depends on the large retailers. This application can be achieved with WORM RFID tag with a unique identification.
- For tracking products, the advantages are primarily enjoyed by the retailers and manufacturers. In this case, additional information on a shipment (such as best before date) can be added. This can be done in several ways, including a read/write RFID tag.
- The use of RFID in returnable transport items cannot be regarded as separate from single use packaging. In the end, both have to use the same infrastructure in the chains.
- For the use of RFID in RTI, the price of the RFID tag is not a major issue. The price of readers, however, plays a more important role.
- RFID in RTI will start with new products launched onto the market, because migration is not a problem in this case.
- The number of RFID pilots in the retail supply chain is increasing significantly in 2004. Of the companies interviewed, almost 50 % will conduct one or more RFID pilots in 2004.
- For 60 % of the companies interviewed, the senior management has a strong interest in RFID. The way in which RFID is embedded in the organisation shows an important difference between the early adopters and the followers.
- 11 of the companies we interviewed expect to have started RFID rollout by the end of 2005.
- The UK is ahead in the implementation of RFID in the retail supply chain.
- Retailers place more importance on case tagging and item tagging than pallet tagging. Case tagging is anticipated sooner than pallet tagging.
- There are large differences in perception as to when RFID will be introduced onto the market on a large scale.
- There is broad support among the early adopters for the EPC standard as the data standard, but not yet for the EPC Network.
- The early adopters prefer UHF as the frequency to use in the retail supply chain. It remains to be seen whether it is feasible to use this frequency for all applications, including products containing a lot of water.
- The early adopters are motivated by long-term vision and expect additional benefits to become clear after RFID is implemented.
- The implementation by the early adopters will create a snowball effect, because RFID is a supply chain matter. This creates an irreversible process, which will force the followers to also implement RFID in time.
- There is currently a large gap in knowledge and vision between the early adopters and the followers. It is very important for all parties to gain experience with RFID technology in the short term.



## 6. Cost and benefit analysis

From the beginning of our study, we have placed great importance on a cost/benefit analysis. The use of RFID in RTI will only ever occur if a good business case exists. However, it is nearly impossible to create a generic business case for RFID in returnable transport items in the retail chain; too many variables have to be considered and the applications of RFID are broad. In addition the situation of each company is different and requires its own specific cost/benefit analysis.



Nevertheless we analyse a generic supply chain model. Although this supply chain model is a simplification, it provides a representative picture of supply chains in the retail market.

The model selected uses pallets as RTI in the flow from the supplier through to the retailer's store. The flow of goods in our model generally concurs with examples such as vegetables or fruit.

### 6.1 Analysis of possible benefits

As stated earlier, we distinguish two different applications of RFID in returnable transport items:

1. The management of RTI (asset management)
2. The tracking of the flow of goods

The possible benefits of both applications are summarised below:

Many of these benefits are difficult to quantify, and depend strongly on each specific situation. For our analysis in the remainder of this section we concentrate on the following benefits:

1. Lower handling costs due to reduced labour costs
2. Lower safety stocks of RTI

All other possible benefits are ignored in the cost / benefit analysis below. It is therefore important to realise that the benefits can be higher in reality than we have calculated.

### 6.2 The generic supply chain

The generic supply chain that we used for our cost / benefit analysis consists of six links.

Application	Possible benefits
Asset management of the RTI Pool	<ul style="list-style-type: none"> <li>Lower safety stocks of RTI</li> <li>Lower transport costs</li> <li>Lower investments</li> <li>Lower control costs</li> <li>Lower shrinkage of RTI</li> <li>Less counterfeiting</li> </ul>
Tracking the flow of goods in the RTI	<ul style="list-style-type: none"> <li>Lower handling costs due to reduced labour costs</li> <li>Fewer delivery and receipt errors</li> <li>Improved replenishment</li> <li>Reduction in inventory</li> <li>Reduction in administration</li> <li>Reduction in loading and unloading times for freight vehicles</li> <li>More efficient recall of goods</li> <li>Less loss and theft of goods</li> <li>Better tracking and tracing for food safety</li> </ul>

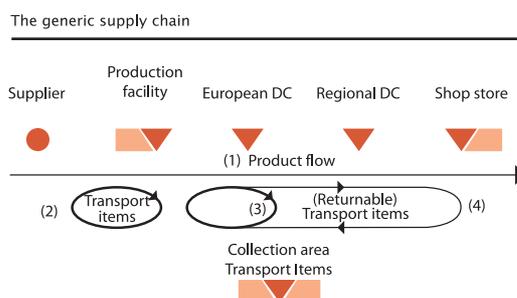


The first five links deal primarily with the flow of goods, while the sixth link handles the RTI flow in the supply chain. The links are:

1. Supplier provides the raw materials for the end product.
2. Production facility processes the raw materials to produce end products.
3. European distribution centre in which the products are delivered and distributed to the regional distribution centres.
4. Regional distribution centre in which goods are stored, repackaged and distributed to the stores.
5. Stores in which the end products are stored on the shelves for sale to the consumer.
6. Collection area for RTI where empty RTI are supplied to or received from the other links. RTI are checked, repaired and stored here.

In practice, not every link in this chain is a separate organisation. On a high level, the production facility and the European distribution centre belong to a food manufacturer, while the regional distribution centre and the stores belong to a retail organisation.

The flow chosen for the cost / benefit analysis essentially conforms to flows 4 in the diagram below, i.e. returnable transport items are used with goods which are sent from a production facility to a store.



### 6.2.1 Process description

At each link in the chain, activities take place in which the use of RFID could provide specific benefits. The various processes and the possible benefits are explained briefly below.

#### Suppliers

The raw materials are transported from the suppliers to the production facility in RTI in this model. By using RFID tags, administrative tasks can be simplified. It is possible to exchange accurate information.

#### Production facility

Goods can be received by the production facility on the basis of the information on the RTI's. Goods can easily be sorted according to supplier, date, etc.

The end product linked to the RTI offers the possibility of being able to track which end products are made from which supplier's raw materials and delivered to which distribution channel. This makes it possible to accurately recall products in the event of problems. In addition, efficiency can be increased with the management of each individual RTI (checking, renovation and repairs) and with the management (stock) of the RTI throughout the whole chain.

#### Central and regional distribution centres

For each stage of the process in a distribution centre, the possible costs and benefits are listed below. With the current status of RFID technology, not all of the benefits described are currently achievable.

1. Freight trucks on the site  
By reading the RTI and / or freight truck as they enter the distribution centre site, it is possible to process the trucks faster. This makes it possible to reduce waiting times at the distribution centre.
2. Unloading freight trucks  
When unloading the trucks, the RTI's are read as they pass through the door to the loading bay. If necessary they can be directly cross-docked, meaning that the freight trucks can be emptied faster.
3. Reception  
The checking process is simplified because the number of RTI's and the information about the goods is directly available on the RTI as it is unloaded. This makes it possible





to directly cross-dock goods.

4. Repacking

Repacking (unpacking and repacking) similar types of products in RTI's (crates) on an RTI (pallet) into different types of products in RTI's (crates) on an RTI (pallet) (multicoloured pallet) can be checked more easily and quickly by reading the RTI pallet and the stacked RTI crates. The combination of RTI crates per RTI pallet must agree with the repacking planning in the warehouse management system (such as crates sorted by store floor), this means that repacking errors can be minimised.

5. Loading freight trucks

By scanning the RTI when loading the freight truck, it is possible to check that the right RTI's have been loaded. This reduces loading errors to a minimum.

6. Freight trucks leave the site

As the freight truck leaves the site, the RTI's are read (including the freight truck) which means that site security can extend right to the boundary of the site without delaying the freight traffic at all.

*Store*

When unloading the freight trucks, the RTI is read and it is checked that the right location is being unloaded. In the store, the RTI can be read as the goods received are transported to the shop floor and / or as they arrive on the correct store floor. In this way, the quantity of goods in the goods inwards area and on the shop floor can be clearly seen.

By improving the delivery of end products it is no longer necessary to hold large stocks of end products. This in turn reduces the income loss due to not having end products in stock.

*RTI collection area*

When dispatching and receiving RTI's, they have to be counted. Because of the large quantities of RTI's dispatched and received every year, counting errors can easily occur. By reading the RTI's, the correct number can be determined. It is also possible to determine which users are responsi-

ble for damage to the RTI's when checking them. If the collection area is informed of the locations of the RTI's by the organisations within the chain, the collection area can make it possible to view the total number of RTI's in the chain. Maintenance programmes for RTI's can be drawn up for individual RTI's. The use of tagged RTI's within the chain also enables locating and preventing use of fake RTI's (imitation RTI's of lower quality).

*Component costs*

For each of the parties in the chain mentioned above, the costs consist of:

- Installation costs for the tag reader and antennas, which should also take into account the electricity supply and network connections for the tag readers and antennas.
- Changes to the software systems and training of staff to use the altered software.
- Training of operational staff due to changes in operational procedures and working methods caused by the use of RFID.
- Creation of new procedures / interfaces for the exchange of information between the parties in the chain.
- New administrative procedures and working methods for each party in the chain.

**6.3 Cost and benefit calculation method used**

To calculate the costs and benefits, we use the SAS Value Chain Analytics tool. This tool uses the principles of Activity Based Costing (ABC), Direct Product Profitability (DPP) and Customer Account Profitability (CAP) methods.

The DPP method was developed at the end of 1970 and is primarily used in retail sectors where chain costs are directly allocated to products. The CAP method dates from the end of 1980 in the supply industry where similar techniques are used as in the DPP method. The ABC method was also developed at the end of 1980. It focuses on the allocation of direct and indirect costs to activities instead of distributing the (indirect) costs over cost components.



## 6.4 Cost and benefit calculation

As mentioned above, we decided to keep the numbers relatively simple when calculating the costs and benefits of the supply chain. The following benefits are quantified

1. Calculation of the benefits per link relating to efficiency improvements in the handling of RTI's. The results are shown per RTI (pallet and roll container (RC)).
2. The reduction in safety stocks of RTI's in the chain. The results are shown per RTI (pallet and roll container (RC))
3. It should also be noted once again that the results of these calculations are not absolute values, but provide an indication (proportions) of the costs and benefits. A more precise calculation is only possible using a real supply chain with actual numbers and values.

### 6.4.1 Calculation values

The following values were used for the benefits: The values chosen are based on empirical data and our own analysis on the basis of market data and interviews.

The following values have been used for the costs:

RFID tag price:	€	0.50
Cost of installation of RFID readers per dock door:	€	30,000.00

The generic supply chain is structured as follows:

- Each link occurs once in the supply chain, apart from the suppliers and stores, which occur 15 times.
- Total RTI quantity to flow through the supply chain is 10,000 per day.
- The total RTI stock in the chain is 100,000. The collection area is the pool manager and owner of the RTI.
- We have assumed 7 working days per week.
- No distinction has been drawn between central and regional distribution centres.
- Each of the 15 stores has one dock door.
- The production facility has a total of 25 dock doors.
- Depreciation period for investments:
  - Tags 7 years (same as the lifetime of the RTI)
  - Readers and antennas 5 years

Benefit	Values
Handling costs per RTI in a distribution centre through increased efficiency	Without RFID, the costs per pallet are € 6.14 (all handling and storage costs). With RFID, the costs are € 5.62, giving a saving of € 0.52. This is an increase in handling efficiency of 8.5 % per pallet.
Reduction in safety stocks of RTI	The total RTI pool can be reduced by 10 % through optimisation



- Interest costs 7 %
- RTI costs
  - Inexpensive pallet € 6.50
  - Roll container (RC) € 50.=
- The lease and deposit for an RTI is the annual RTI price plus a storage percentage totaling 25 %.

#### 6.4.2 Starting points for the calculations

To keep the cost and benefit calculation as simple and clear as possible, the following assumptions have been made:

1. The costs for changes to and integration with existing software applications (e.g. WMS and ERP systems) are not taken into account in the cost and benefit analysis.
2. The costs of RFID tags, readers / writers and antennas are fully allocated to RTI's. We do not, therefore, take disposable packaging into account in the supply chain. The generic supply chain in our model consequently consists solely of RTI.
3. Efficiency improvements (or deteriorations) due to the use of RFID by the supplier, in the production facility and in the stores are not taken into account in the calculations. The gain in efficiency is highly dependent on how the end products are handled in the production facility. This can depend either on the production method or the type of product and packaging.
4. Any other possible benefits are also not taken into account in the calculations. These include fewer delivery and reception errors, reduced stocks, lower administrative costs, reduction in loading and unloading times for freight trucks, more efficient recalls of goods, fewer losses and thefts of goods and fewer fake RTI's.
5. Transport costs between the parties in the chain are not considered.
6. Cost components such as the cost of training staff, changes to the organisation are not taken into account in the calculations.

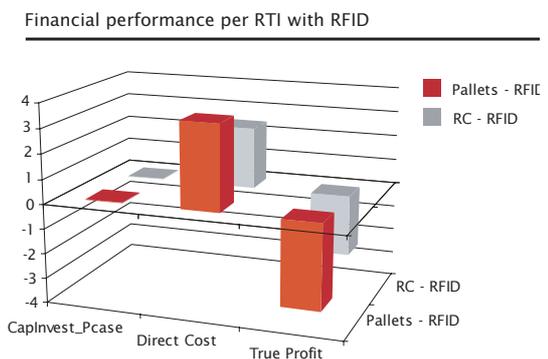
#### 6.4.3 Results of the calculations

The results of the calculations are expressed in the following components:

- **Capital Investment:**  
Capital investment includes investment in gates, readers, tags and antennas. Tags are depreciated over 7 years, the other investments over 5 years. The costs are fully allocated to the pallets and roll containers that use these gates.  
The investments are calculated back to pallet or roll container level. This means that the investments calculated are highly dependent on the size of the RTI flow through the chain per unit of time.
- **Direct costs:**  
Direct costs include all handling costs that are directly allocated to the RTI. Storage costs and capital investment also fall into this category.
- **Cash profit:**  
Gross income per RTI. This includes the income from the hire of the RTI less the purchase costs of the RTI. This means that this component is positive for RTI lessors but negative for RTI lessees.
- **True Profit:**  
This is the actual profit earned from an RTI.
- **Net Present Value:**  
In addition to the calculation per RTI, we also show the Net Present Value of the use of RFID for the whole supply chain.

#### Calculation 1a.

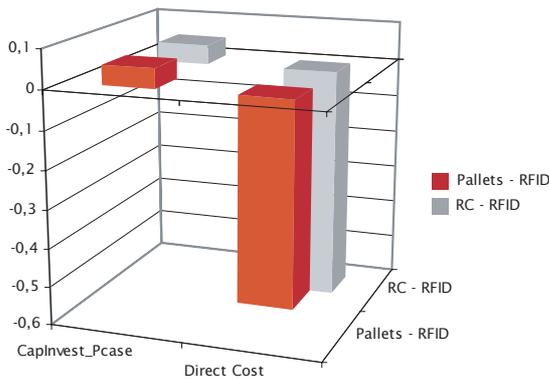
Firstly, a calculation is made to determine the total investment costs per RTI and the handling costs per RTI in a distribution centre. This calculation shows that the costs for RFID investment per RTI are low in comparison with the handling costs.



**Calculation 1b.**

The calculation shows that the savings in handling costs are much higher than the investments that need to be made for RFID. The handling costs with RFID are between 0,52€ (for pallets) and 0,60€ (for RC) lower than without RFID. The RFID investment per RTI is only a few Euro cents.

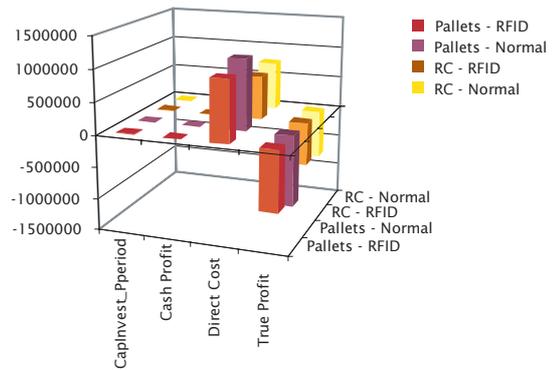
Additional investment and cost saving per RTI with RFID



**Calculation 2**

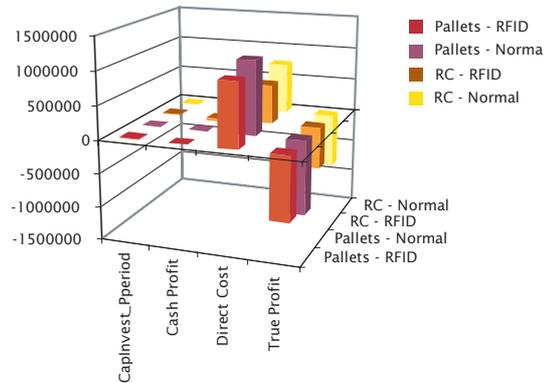
Calculation 2 was made with 10 % fewer RTI's required in the chain. The results show that the reduction in RTI in the chain makes a positive contribution to cost reductions. However, these cost reductions are significantly less than the reduction in the handling costs. The calculation was made over a period of 4 weeks. The same handling costs and cost reduction are also assumed for the RTI owner as for a distribution centre.

Financial performance with and without RFID for RTI owner



The chart below shows the calculation made for the RTI lessee. Here too, it appears that the lease cost is minimal in comparison with the handling cost.

Financial performance with and without RFID for lessee





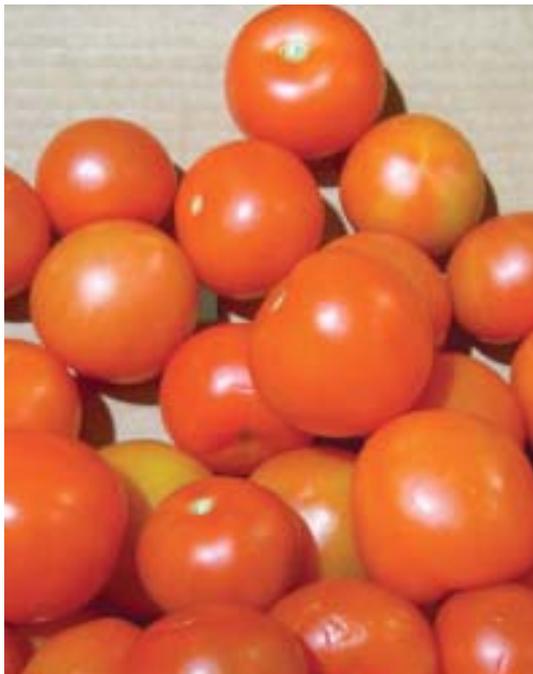
### Calculation of Net Present Value

In addition to the calculation of costs and benefits by RTI above, we have calculated the Net Present Value of RFID for the whole chain. The same bases for calculation were used. The starting point is that all costs are incurred in the first year. The costs consist of tags, readers and antennas. The benefits are enjoyed in year 2 to 5, with an additional one off benefit in year 2 from the reduction in safety stocks. All other benefits consist of the reduction in RTI handling costs are due to improvements in efficiency.

For this calculation, we used a timescale of 5 years, with the costs and benefits distributed as follows:

	Year 1	Year 2	Year 3	Year 4	Year 5
Costs	3,710	-	-	-	-
Benefits	-	3,562	2,912	2,912	2,912

in thousands



With a discount factor of 10 % and a timescale of 5 years, this calculation results in the following Net Present Value:

Net Present Value € 5,555,961.00

The payback period for the investments in RFID technology is between two and three years in this case.

### 6.5 Conclusions

We can draw the following conclusions, bearing in mind that these are based on a highly simplified supply chain:

- In our generic supply chain, the use of RFID on RTI provides a positive business case for the chain as a whole.
- The benefits will primarily occur where large quantities of RTI are read per tag and reader per unit of time and where the RTI handling costs can be substantially reduced by the use of RFID. This will primarily apply to distribution centres and RTI owners (pool managers).
- The main driver for the business case is the reduction in handling costs. The benefits from reducing the number of RTI in the chain is relatively low compared to the benefits from reducing handling costs.





## 7. Preparation & Implementation

The previous sections clearly indicate that many organisations plan RFID pilots and implementations in the next few years. However, the implementing RFID is a complex task with far reaching consequences. In this section we analyse the issues that companies face when implementing RFID.



Our goal is not to present a methodology for organisations who want to implement RFID. Sufficient information on this topic is already available (the Global Commerce Initiative has presented the EPC Roadmap and LogicaCMG has a similar approach called the RFID Accelerator). Instead, we analyse the potential implementation issues by simplifying the introduction of RFID into two phases: the preparation phase and the implementation phase.

## 7.1 Preparation phase

We cannot emphasize enough that RFID is only a tool, like any other technology. Creating business benefits enabled by this technology requires changes to business processes and existing ICT applications. In addition, the relationships with clients and suppliers may be impacted, for example regarding information sharing. It demands a large investment in financial and human resources, with a programme of ICT, logistics and organisational projects.

In the preparation phase companies need to develop a strategic vision of the possibilities of RFID for their organisation, based on a deep understanding of the business processes and business pains. Initial business cases will need to be developed. When we look at open supply chain applications, it is also necessary to choose the right trading partner(s). This can be a complex process in which various factors play a role.

As part of their RFID strategy, retailers and manufacturers need to develop a privacy policy and communicate this to consumers. Despite the fact that consumer privacy is not an issue with RFID on returnable transport items, there is a risk of misconception about RFID technology among consumers.

In addition, the consequences for ICT systems will be considerable: much more data, much more information and reporting. An in-depth analysis of the impact on ICT systems is therefore essential in the preparation phase. Many companies believe that data must be 'cleaned' to create significant value from RFID in open supply chain applications.

Achieving data synchronisation with clients and suppliers on the basis of 'cleaned' master data is a large and time consuming process by itself.

Because of the complexity of the RFID implementation, we advise a step-by-step introduction of RFID, from study, piloting, small-scale projects to large-scale applications. Organisations will go through an iterative process of learning, experimenting and evaluating. For example, pilot projects should be used to validate and strengthen business case analyses.

We expect this path to be longer for the early adopters than for the followers. Firstly, because the followers will benefit from the lessons learned by the early adopters. Secondly, because the early adopters need to work with immature technology, especially in the UHF area and in software integration. This is illustrated by an RTI pool organiser that plans to have UHF RFID tags moulded into new plastic containers. The product development has been delayed by a year due to problems with the reliability of the technology.

All in all, it is clear that organisations will go through an extensive preparation period before RFID is implemented on a large scale.

## 7.2 Implementation phase

Once organisations take the first step towards implementing RFID on a large scale, a number of important migration tasks have to be completed. Moreover, a number of important conditions have to be met. These issues may not be very important in a pilot project, but are essential for large-scale implementation:

1. The technology must be 100 % robust and reliable
2. Distribution of costs and benefits must be clear
3. System integration and data synchronisation must be completed

*1. Technology must be 100 % robust and reliable*

When RFID is rolled out in the organisation, the read reliability of the tags must be (practically)





100 %. There must also be a solution for exception processing. The fact that 100 % read reliability is difficult to achieve was clear from an interview with a large retailer. This retailer has already fitted a large number of plastic crates with RFID tags, but is currently only tracking them in one distribution centre. The company will proceed with the roll out to other distribution centres when read reliability is almost 100%. When it starts the roll-out to other distribution centres it will take time to achieve the same level of reliability, as every environment has different factors that need to be taken into account.

In addition, it is also necessary to be clear about what happens if an error occurs in reading a tag in the distribution centre. In a pilot, errors and their consequences are part of the learning process, but this exception processing is essential in a full-scale implementation.

## *2. Distribution of costs and benefits must be clear*

A large-scale RFID roll out demands large investments, with costs and benefits not necessarily distributed proportionally between the various internal and external interested parties. A large roll out can only take place if this cost/benefit distribution has been resolved. Two large retailers said that they are working together with suppliers on RFID, whereby the suppliers themselves must recognize the benefits of using RFID before tagging the products. This process can therefore have a delaying effect on the adoption of RFID.

## *3. System integration and data synchronisation must be completed*

In a pilot project, changes to existing IT systems are not yet essential. In a large roll out they are necessary. As with any IT project, significant risks are involved. Although major investments are currently being made in RFID middleware to achieve the integration between the RFID hardware and the existing software applications, this is still an immature sector of the market.

As stated earlier many companies indicate that data synchronisation is a precondition for large scale RFID implementation. It should be noted here that this certainly applies for open supply chain implementation of RFID, but that it is of less significance for more internally oriented RFID implementations.

If these conditions are met, it is still possible that issues arise that may delay the RFID implementation. Two potential issues include the availability of technical expertise and issues surrounding project ownership.

A large CPG manufacturer indicated that it is conducting a number of RFID pilots in which the hardware installation and integration is provided by various small companies. Although these small companies perform well in the pilots, the manufacturer was concerned about these hardware integrators in large-scale (worldwide or European) roll outs. This CPG manufacturer, as well as other companies, fear a shortage of technical expertise in the field of RFID hardware installation and integration European level and organisation willing to take responsibility for this on a European level.

In addition, some companies are concerned about the large number of different parties involved in RFID implementations: RFID tag suppliers, reader suppliers, hardware integrators, system integrators and possibly business consultants. If a problem arises with the implementation, it can be difficult to determine who is responsible for solving it.

Finally, there are issues that specifically affect returnable transport items, particularly the migration from an existing pool and the fitting of RFID tags on the RTI.

Organisations that have already gained experience with fitting RFID tags to existing RTI pools frequently experienced delays in this process. A specific problem is that fact that it is often difficult to fit 100 % of the items in the pool with RFID tags, especially in an open system.



In addition, it is also often difficult to find a robust solution for an RFID tag on a specific RTI. For example, a retailer who had already fitted RFID tags to roll containers, had to spend a lot of time developing a robust tag that combined an RFID tag with a barcode. Other companies have invested a great deal of time in finding the right technical solution for the fitting of an RFID tag to a pallet. We expect that the knowledge gained by these early adopters will help to limit these issues for the companies that follow later.

### 7.3 Conclusions

- The implementation of RFID on a large scale has far reaching consequences for business processes, ICT systems and relationships with clients and suppliers. It demands a programme of projects in the fields of ICT, logistics and organisation.
- The preparation period for RFID implementation is long, with a step-by-step introduction involving research, piloting, small-scale projects and then large-scale applications. For the early adopters, this path will be relatively long due to the immaturity of the technology and the limited experience with RFID in the retail market. Not all of the consequences of RFID for organisations, their processes and systems are clear at this time.
- Consumer privacy is not an issue with RFID on returnable transport items. However, there is a risk of misconception about RFID technology among consumers. As part of their RFID strategy, retailers and manufacturers need to develop a privacy policy and communicate this to consumers.
- When the preparatory phase is completed and RFID is implemented on a large scale, important conditions must be met. Firstly, the RFID technology must work 100 % reliably. There must also be a clear distribution of costs and benefits between the parties involved. Finally, the necessary system integration must be completed, including possible data synchronisation with clients and suppliers.
- In addition, it is possible that organisations may be confronted with specific migration issues during the implementation, such as the availability of technical expertise and issues surrounding project ownership. Furthermore, for returnable transport items in particular, it can be very difficult and time consuming to fit RFID tags to an existing RTI pool.
- All in all, it may take the early adopters a long time to get from the pilot stage to the full roll out, possibly longer than we currently expect.





## 8. Conclusions

The question when and how RFID will be adopted in returnable transport items (RTI's) in the European retail market is central to this study.

We conclude that this is the right question to ask: it is no longer a question if RFID will be used; it is just a question when this will happen.

The starting point for this study is the European retail supply chain. The performance pressure on this supply chain has increased significantly over recent decades.



Retail organisations have become more dominant, mainly because of consolidation. As a result, retailers also play a leading role in the introduction of RFID.

Despite the increased performance of the supply chain, many opportunities for improvement still exist, for example through supply chain collaboration. In many cases information problems underlie logistics problems. ICT solutions such as barcoding and electronic communication are still not sufficiently used.

Returnable transport items are widely used in the European retail supply chain, in a large variety of materials, sizes and weights, depending on the application and the product to be transported. Often they are used in a pool, managed by a RTI pool organiser or logistics service provider. The management and administration of the pool is often complex, because of limited supply chain visibility. The identification and registration of the RTI's using barcoding only occurs to a limited extent.

## RFID technology and issues

RFID technology makes it possible to identify and track objects without time delays, without human intervention and thus without variable costs. In principle, the logistics process can be optimised better with RFID than with barcodes.

Despite these advantages of RFID, there are still a number of issues:

- There is not one clear frequency. UHF (Ultra-High Frequency) technology is the most appropriate for supply chain applications due to the reading range and speed. The question remains whether this technology can be used in environments and products containing a lot of water.
- It is necessary to take into account the environment in which RFID is to be used, such as the influence of water or metal and possible interference.
- Software to integrate RFID with business applications is currently not fully developed. In a few years, this will become a standard

part of ERP, WMS and supply chain management applications.

- Standardisation is currently not yet finalised, despite the recent progress with the EPC standard. Furthermore, EPCglobal, the organisation that implements this standard, is still operating in start-up mode.
- Due to the limitations in European legislation, the use of UHF technology is currently limited in Europe. This means that the products available are relatively immature.

We anticipate that the issues with standardisation and European legislation will be resolved by the end of 2004. From 2005 onwards, UHF products will be available on the European market that meet these standards.

Due to the physical characteristics of RFID technology and the limited knowledge and experience, RFID implementations in the near future continue to be time consuming and tailored to each specific environment.

The cost of RFID tags will fall further in the next few years due to the anticipated increase in volume. A price for a passive WORM (write-once read many) tag of 0,05€ in 2007-2008 is possible. For RTI the price of the tag is less important because they can be reused throughout the lifetime of the RTI. A further drop in the price of RFID readers is also anticipated, although this is harder to predict.

## Applications of RFID in RTI

Two main applications of RFID in returnable transport items are distinguished: (1) asset management of the pool of returnable transport items and (2) tracking the flow of goods on or in the returnable transport items.

- (1) For RTI asset management, the benefits are mainly realized by the RTI pool organiser who can manage the pool more efficiently. The benefits are significant; it becomes possible to reduce safety stocks, make savings on transport, reduce administration and checks on the assets, reduce shrinkage and



counterfeiting, and offer new services. However, the RTI pool organisers are dependent on the large retailers and manufacturers, who also need to gather data via RFID readers in their supply chain.

- (2) The advantages of tracking the flow of goods with RFID are primarily for the retailers and manufacturers. In this case, additional information on a shipment (such as best before date) can be provided. This can be done in various ways, including using a read/write RFID tag. In this case the use of RFID in returnable transport items cannot be regarded as separate from disposable packaging. In the end, both types of packaging use the same infrastructure within the chain. The possible advantages that can be achieved are diverse:
- Efficiency improvements in RTI handling
  - Fewer delivery and reception errors
  - Improved stocking
  - Reduced stocks
  - Reduction in administrative tasks
  - Reduction in loading and unloading times for freight trucks
  - More efficient goods recalls
  - Less loss and theft of goods
  - Better tracking and tracing for food safety

## The business case for RFID

We have quantified the costs and benefits for using RFID in RTI in a generic supply chain model. We concentrated on two possible benefits: the reduction of RTI safety stocks and efficiency advantages in RTI handling. All other possible benefits were left outside our consideration in this analysis.

A realistic cost/benefit analysis for a generic supply chain model is difficult to make. In reality, each situation is different and in a generic model assumptions have to be made which quickly become unrealistic, such as a chain that consists solely of returnable transport items. Despite these limitations, we believe that the model we have used is suitable to provide an indication of the cost/benefit details in the chain.

In our generic supply chain, the use of RFID gives a clear positive business case, even if we only focus on efficiency improvements in RTI handling and reductions in RTI safety stocks. The advantages are primarily for the distribution centres and the RTI pool organiser. The pay-back period is two to three years.

## The findings of the interviews

It is important to see whether organisations are actually working towards the implementation of RFID. To this end, we interviewed 50 organisations, including 18 large European retailers. These interviews revealed the following:

- The number of RFID pilots in the retail supply chain increases significantly in 2004. Almost 50 % of the companies will gain experience with RFID in 2004 through a pilot project.
- Eleven of the companies we interviewed will start to implement RFID before the end of 2005. The majority of the followers also expect to start RFID implementation within 2 to 3 years.
- 60 % of the companies indicated that RFID is high on the agenda of senior management. The way in which RFID is embedded in the organisation shows a great difference between the early adopters and the followers.
- The UK is ahead of the rest of Europe in the implementation of RFID.
- Case level tagging is expected sooner than (physical) tagging of pallets, because retailers create more value with case tagging than with pallet tagging.
- There is broad support among the early adopters for the EPC standard as a data standard, but not yet for the EPC Network.
- The early adopters prefer UHF as the frequency to use in the retail supply chain. The question is whether it is feasible to use this frequency for all applications, i.e. products containing a lot of water.
- The early adopters are motivated by a long-term vision, and expect additional benefits to become clear after RFID has been implemented. There is a large gap in knowledge



and vision between the early adopters and the followers.

- Because RFID implementations impact the entire supply chain, the work of the early adopters will create a snowball effect. It is important for all parties to gain experience with RFID technology in the short term in order to understand the possibilities and limitations.
- RFID on RTI's will start with new products brought to the market, because migration is not a problem.

### **The influence of implementation issues**

The interviews show that RFID will actually be implemented on a large scale over the next few years, driven by the large retailers and the RTI pool organisers. It is important to analyse the possible issues these companies will face, both in the preparation phase and during the actual implementation.

The implementation of RFID on a large scale in the supply chain will have far reaching consequences for business processes, ICT systems and the relationships between clients and suppliers. It demands a large investment in financial and human resources for each organisation, with a programme of ICT, logistics and organisational projects.

The preparation period for RFID implementation is long, consisting of a step-by-step introduction based on study, piloting, small-scale projects through to large-scale applications. For the early adopters this path will be relatively long because the technology is immature and there is only limited experience with RFID. Not all of the implications for organisations, their processes and systems are clear at this time.

Consumer privacy is not an issue with RFID on returnable transport items. However, there is a risk of misconception about RFID technology among consumers. As part of their RFID strategy, retailers and manufacturers need to develop a privacy policy and communicate this to consumers.

Before a large-scale RFID implementation can start, the RFID technology must work 100% reliably. The distribution of costs and benefits between the parties involved must also be clear. Finally, the necessary system integration must be carried out, including possible data synchronisation with clients and suppliers.

In addition, organisations may be confronted with specific migration issues, such as project ownership and the availability of technical expertise during the implementation period. A number of organisations fear a shortage of engineers for the hardware installation in large-scale implementations.

For returnable transport items in particular, it is difficult and time consuming to fit an existing RTI pool with RFID tags.

In summary, companies will gradually introduce RFID technology in supply chain applications over the next few years, despite the current technical and organisational issues. It will require a lot of effort, but the early adopters, mainly large retailers and RTI pool organisers, are already starting. These implementations have an impact on the whole chain and will lead to an irreversible process. The followers, who are currently still just watching, will also implement RFID over time. Because of the far reaching consequences, these organisations should gain knowledge and experience as quickly as possible.





## 9. Roadmap

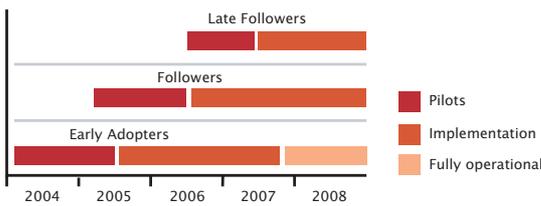
We started this study with the aim of determining when and how RFID would be used on a large scale in returnable transport items in European retail. In the previous sections we have analysed the factors that we believe will influence this question. It has become clear that RTI will be fitted with RFID tags in the future, given the many advantages that this offers.

On the basis of this analysis, we have shown our expectations in the diagram below, with the note that this is a simplification of reality.



The distinction between early adopters, followers and late followers is not as black and white as this diagram implies.

RFID adoption roadmap



We briefly explain this roadmap above, describing the most important developments in each year.

**2004:**

- The number of pilots increases rapidly, with all RTI pool organisers gaining experience with RFID in returnable transport items.
- EPC standard Class 1 Generation 2 is published and European legislation on UHF is amended, solving two important problems for the European market.
- EPCglobal becomes operational.

**2005:**

- Reliable UHF products are available on the European market.
- The first RTI pool organisers offer crates fitted with RFID tags.
- Large retailers such as Wal-Mart, Tesco and Metro start a large-scale roll out, i.e. throughout the whole organisation, at least at case and crate level.
- The number of followers starting pilots increases quickly.

**2006:**

- Early adopters are fully occupied with implementation, possibly facing issues with system integration.
- The first followers start their implementations.
- The late followers are also slowly starting the first RFID pilots.

**2007:**

- Price of a passive RFID tag falls to 5 Euro cents.
- Followers now occupied with implementation, followed by the late followers who had a relatively short pilot phase.
- The first early adopters complete their RFID implementation with logistics applications.

**After 2007:**

- In the years after 2007, interest slowly shifts towards item level tagging, but it will be some time before this is used.





## Appendix 1: Overview EPC Network

The EPC standard has gained wide support in the retail industry. This standard was developed by the Auto-ID Center, and is currently implemented and enhanced by EPCglobal, a subsidiary of EAN International and UCC. In this appendix we describe both the EPC data standard, as well as the vision for the EPC Network.

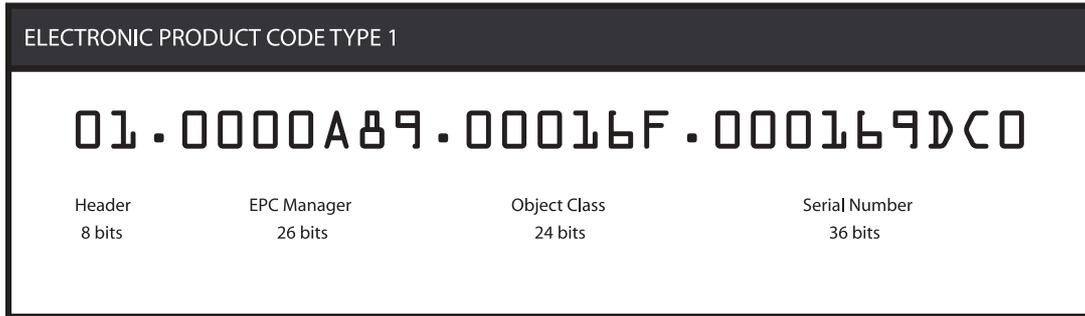


## The Electronic Product Code (EPC)

EPCglobal presented the new Electronic Product Code as the next generation of standards for product identification. EPCglobal wants to stimulate the use of EPC by giving the EPC the same basic structure as the Global Trade Item Number (GTIN).

## EPC compliant tags

The Auto-ID Center has developed different tags, which are currently not interoperable, including a read-only tag (Class 0), and a write-once, read-many tag (Class 1).



Source: Auto-ID Center.

### How does an EPC work ?

The EPC consists of a "Header", "EPC Manager", "Object Class" and a "Serial Number".

The "Header" contains the EPC version number. The "EPC Manager" includes the manufacturer of the product (e.g. 'Coca-Cola Company').

The "Object Class" gives the type of product, in most cases the SKU (Stock Keeping Unit) for the product (e.g. 'Cola 330 ml can').

The last is the serial number - unique for each product - that precisely identifies which can of cola we are dealing with. This makes it possible, for example, to find products quickly if the best before date has passed.

### EPC variants

EPCglobal provides 64 and 96 bit EPC codes with the possibility of larger variants. The 96 bit variant is the most commonly used and provides a unique identification for:

- 268 million companies,
- 16 million object classes per company and
- 68 billion unique serial numbers per class.

This provides more than enough EPC codes to identify all products produced worldwide.

### Future development: UHF Generation 2 Foundation Protocol

EPCglobal is currently developing a standard that merges Class 0 and Class 1 protocols, and that can be used as a proposed ISO standard. The standard currently being developed is called Generation 2 Foundation Protocol, or EPC Class 1 Generation 2. It is expected that this standard will be available before the end of 2004.



The following table provides an overview of the evolving EPC protocols (source: RFID Journal)

Protocol	Frequency	Description
Class 0	UHF	Read-only, factory programmed
Class 0 Plus	UHF	Read-write
Class 1	UHF, HF	Write-once, read-many (WORM)
Class 1, Generation 2 (Generation 2 Foundation Protocol)	UHF	WORM, can be used globally; merges Class 0 and Class 1 and perhaps ISO
Class 2	UHF	A proposed read-write tag

## EPC Network

At the moment, EPCglobal is developing and testing the EPC Network. This network will make it possible to use the internet to exchange information about objects. Version 1 specifications are available from EPCglobal and describe the various parts of this network.

### Savant

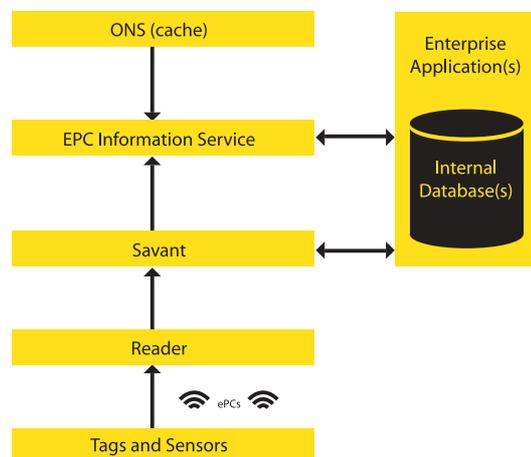
The Savant is middleware software that makes it possible to process the huge flows of data from the tags and sensors. The main job of Savant is to collect and filter the tag data so that the data volume is reduced and the exchange with the business applications can take place.

### EPC Information Service (EPC IS)

This Information Service converts EPC Network related data into PML format and makes this available to the applications that need this data. The data that the EPC Information Service can provide includes:

- Read tag data from the Savant,
- Batch related data, such as production date and best before date from the Enterprise Application,
- Object information, such as extra product information.

The EPC Information Service can use the various sources of data that exist within an organisation.





### Object Name Service (ONS)

Only one EPC code is stored on a tag. This EPC must be linked to a location where information on the object concerned can be found. This is the function of the ONS, a worldwide internet service (comparable to Domain Name Service, DNS), which points computers to locations on the internet. Alongside this worldwide ONS, a local ONS service should also be active within the organisation, known as ONS Cache. This local ONS service stores all recently requested locations, so that there is no need to be continually requesting the same information from the worldwide ONS.

In January 2004, EPCglobal has awarded a contract to VeriSign to provide the services for the global ONS root.

### Physical Markup Language (PML)

The EPC code identifies the object, but all the information about the object has to be looked up via the internet. The exchange of this information is via reports compiled in the new Physical Markup Language. PML is based on XML.

### How the EPC Network works

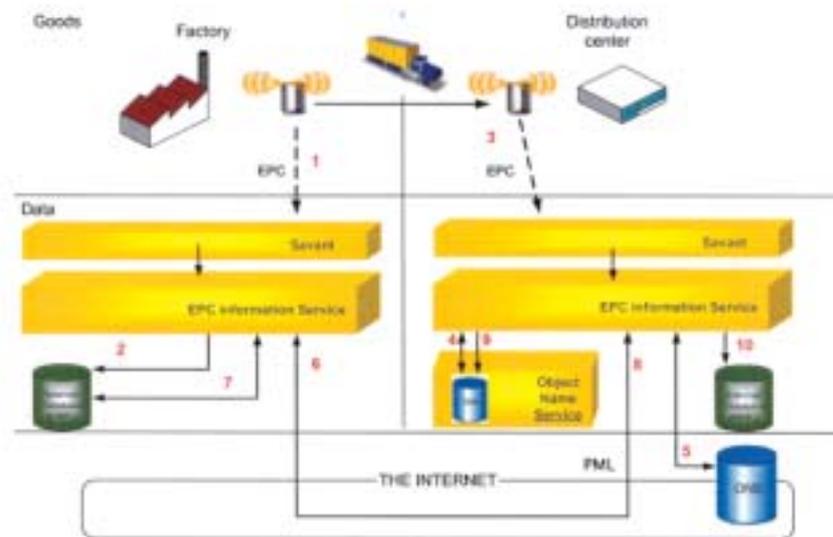
This diagram describes the process of delivering goods from a factory to a distribution centre (DC).

The goods are scanned as they leave the factory (1). The EPC codes are stored as sent in the Business application (2).

The goods arrive at the DC and are scanned again (3). The EPC codes appear to be unknown to the local ONS at the DC (4). The EPC IS at the DC will now report the EPC codes to the worldwide ONS. The worldwide ONS will then point the EPC IS to the location where the information is available (5). The EPC IS at the DC will now make contact with the EPC IS of the manufacturer via the internet and request the information on the EPC codes (6). The manufacturer's EPC IS will request the information from its own business application (7) and translate this into a PML report. This report is then sent to the EPC IS at the DC (8). The local ONS at the DC can now be improved with the location information from the manufacturer's EPC IS (9). The EPC IS at the DC can finally translate the PML report into information that can be stored in its own business application (10).

### Real-time Tracking & Tracing

With the EPC Network, computers will be able to track and trace physical objects, allowing companies to automatically follow items throughout the supply chain. This network can be enhanced with additional technology like GPS and GSM for real-time tracking and tracing of items that are en route to a warehouse or a store.





## Appendix 2: Overview of RFID middleware

Many software providers are currently developing software to integrate RFID data with existing software applications. This includes ERP, WMS and traditional middleware vendors. This section provides an overview of the current marketplace.



Software Supplier(s)	Solution / Product	When available
SAP	Auto ID Infrastructure (All)	The package is currently available only to pilot customers, but it will be more widely available to customers in mid-2004.
Oracle	Oracle Warehouse Management	The next version of Oracle Warehouse Management is scheduled to be generally available in the Summer of 2004.
Microsoft	Business Solutions	Expand the pilot work in 2004 and to RFID-enable upcoming releases of Axapta and Business Solutions-Navision(r) in 2005. In 2006, Microsoft plans to release a version of Retail Management System that is RFID-enabled.
IBM	IBM WebSphere(r) MQ WebSphere Business Integration IBM DB2(r) Everyplace(tm) IBM eServer(tm)	Currently available
Marc Global	MARC Suite(tm) RFID Solutions	Currently available
Manhattan Associates	RFID in a Box	Currently available
WebMethods	Integration Platform	Currently available
Tibco	TIBCO(r) business integration and business optimisation software	First half of 2004
Sun Microsystems	Sun(tm) Open Net Environment (Sun ONE) Integration layer	Currently available





## Description

Adds a layer of intelligence between the reader and the application. It collects, analyses and manages high volumes of real-time information from tagged items, environmental sensors and real-time locating systems.

The new version of Oracle Warehouse Management will enable pallet- and case-level tagging for automatic processing of inbound and outbound shipments.

SQL Server providing the functionalities that are needed for RFID data management, BizTalk that can take data feeds from a reader, aggregate the data, do data smoothing and filtering, and then store the data.

Microsoft plans to provide the infrastructure capable of supporting real-time decision-making through a combination of SQL Server Accelerator for Business Intelligence and BizTalk.

IBM WebSphere(r) MQ and WebSphere Business Integration, which allows end-to-end integration IBM DB2(r) Everyplace(tm), which supports handheld devices and provides data synchronization with larger systems.

IBM eServer(tm) systems, which offer self-managing and self-optimising features.

Compliance Kit(tm) meets Wal-Mart and Department of Defense mandates requiring the placement of tags on shipments of pallets and cases.

Enterprise Edition(tm) provides the necessary interfaces (APIs) to connect with MARC's existing SCE applications.

MARC Global's expanded RFID offerings are built upon OATSystems' Senseware(tm) middleware platform.

The "RFID in a Box" solution includes RFID readers, antennas and limited license version of Manhattan Associates' Trading Partner Management application, allowing them to generate RFID label tags and apply them to goods.

WebMethods Integration Platform provides connectivity to Manhattan's warehouse management applications and other critical back-office applications.

With the existing WebMethods Integration Platform, companies can integrate RFID with their core back-end systems.

Together with OATSystems' RFID application, Senseware, the solution tracks all assets and inventory with RFID tags, automates data capture to eliminate manual count, bar code scanning and data entry.

TIBCO and Alien Technology are working together to develop RFID solutions that integrate real-time events generated by Alien's hardware with the entire enterprise via TIBCO business integration software. TIBCO business integration and business optimisation products will provide visibility and analysis of RFID events, enabling organisations to react more quickly to changing business conditions.

The Sun ONE Integration layer provides several options for integrating Savant servers with existing systems through either the Sun ONE Application Server, for point-to-point integration, or the Sun ONE Integration Server EAI Edition, for tying multiple systems into a complex workflow.





## Appendix 3: Case Studies

Three case studies for the use of RFID in returnable transport items will be discussed in this appendix:

- Hoogvliet: RFID tags on roll containers in the distribution centre
- Hays Logistics: RFID on crates in European supply-chain
- CHEP: RFID on pallets



**Hoogvliet: RFID tags on roll containers in the distribution centre**



Hoogvliet is a medium-sized Dutch supermarket chain with 1 distribution centre, 39 stores and an annual turnover of 425 million Euros.

*Objectives of the project*

Placing RFID tags on roll containers is part of a logistics improvement process for Hoogvliet, in which the processes within the distribution centre and towards the stores are being optimised.

*Chosen technology*

TrolleyTrack has developed an integrated RFID tag and barcode for Hoogvliet, which has been fitted to 8000 roll containers. The RFID tag is from Texas Instruments and operates at low frequency (134 kHz). Readers are placed in the floor at each dock door in the distribution centre. In addition, all trailers are fitted with RFID tags that are read by readers in the dock door.

*Status*

After some initial problems with the RFID technology, the system is now fully operational. If a roll container is loaded into the wrong freight truck, an alarm goes off which only stops once the roll container is removed again. This rules out incorrect deliveries.

*Future expectations*

At the moment, Hoogvliet is working on developing applications to further optimise the distribution process. It is worth considering fully matching each run with the appropriate roll containers (thus also providing completeness checks) and optimising the picking process.

**Hays Logistics: RFID on crates in European supply-chain**



Hays Logistics is a large logistics service provider with a strong position in the fresh food chain. The Hays Chilled Logistics & Services division has been working for a few years on a project in which RFID technology is used in plastic containers that are used in the European distribution of fresh meat to retailers. Hays is working with Bekuplast in this project. This project, known as the info-Box System (iBoS), is financially supported by the European Union's IST programme.

*Objectives of the project*

The objective of iBoS is to increase the transparency of the logistics chain of meat products by electronic identification in order to improve food safety and logistics efficiency. The iBoS system consists of a new plastic container with built-in RFID tag and an Internet-accessible Supply Chain Management System.

With this technology, it is possible to read 250 crates at the same time, making it possible to track each individual crate instead of just the complete pallet. According to Hays, the various parties in the chain have also benefited from the fact that the system can help to regain the damaged trust of the consumer with regard to food safety.

*Chosen technology*

Hays has chosen 13.56 MHz (High-Frequency) RFID technology, with read/write tags moulded into the crates by Bekuplast. The crates can not only be uniquely identified, but they can also contain information on each shipment. Readers are placed at various points in the chain (abattoir, distribution centre and possibly stores).



### *Status*

Hays has carried out numerous trials, both internally and with trading partners. A definitive test is starting in spring 2004.

### *Future expectations*

Hays' crates are used throughout the whole chain and the future success is therefore highly dependent on the support Hays obtains from its trading partners and thus on standardisation. The frequency in particular plays an important role here, since large retailers have expressed a strong preference for UHF on the basis of the EPC standard, whereas Hays does not consider this frequency to be appropriate for use with meat and fish products due to the high water content. Furthermore, Hays says that the meat processing industry also prefers HF technology for the same reason.

### **CHEP: RFID on pallets**

CHEP is a global RTI pool organiser with a strong position in the retail supply chain and clients such as Tesco, Unilever, Carrefour, Nestle, Procter & Gamble. With a pool of 200 million pallets, it is the world's largest pallet supplier. CHEP has been working for five years on RFID in returnable transport items. According to RFID Journal, it has invested a total of \$ 20 million in RFID technology in this period. The largest pilot took place between May 2002 and May 2003 in the CHEP distribution centre in Florida, USA. During this pilot scheme, 250,000 pallets were fitted with UHF RFID tags.

### *Objectives*

Like other RTI pool organisers, CHEP anticipates outstanding possibilities for optimising the management of the RTI pool with the help of RFID. Alongside this, RFID provides the opportunity to offer new services to clients.

### *Status*

In recent years, CHEP has built up a great deal of knowledge about the use of RFID in pallets. At the moment, CHEP has optimised the positioning of the tag on the wooden pallet (after an extensive learning process) and has achieved read reliability of almost 100 %. For the pilot in Florida 250,000 pallets were fitted with UHF tags. This made it possible to track where the pallet went, which pallets were returned and which pallets were damaged. This pilot gave CHEP a better insight into its existing processes.

### *Future expectations*

Although CHEP has invested a lot in RFID, it is currently not clear whether and when CHEP will actually fit its entire pool of wooden pallets with RFID tags. The tag for a pallet costs around \$ 1 US, so the costs are enormous for a pool of 200 million pallets. In addition, migration is a possible issue in such a worldwide pool. It is more likely that CHEP will add tags to a part of its pallet pool, and provide these as a separate service. Perhaps Wal-Mart's mandate to demand RFID



tags on all pallets and cases from suppliers may play a significant role here. This was confirmed in March, 2003 when CHEP launched PLUS ID, a service that includes RFID-enabled pallets; support applications to collect, store and process data; and upgrades to ensure compliance with emerging EPC standards. CHEP plans to charge a premium on its existing rental fees, but says the exact amount of the premium will not be set until it completes trials with several customers.





## Appendix 4: Sources



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- *"EPC Roadmap - Executive Summary"* - Global Commerce Initiative, November 2003





## Appendix 5: About the authors



Eelco de Jong

Eelco de Jong leads the RFID solution development for LogicaCMG's Industry, Distribution and Transport division. Eelco has over 7 years experience in the telecom and CPG & retail markets. He is a recognized expert in the field of RFID and often consults companies on this topic. Eelco has initiated and raised the funding for this RFID Benchmark study. He has also conducted interviews with leading international retailers and CPG manufacturers and authored a number of chapters.

Mark van den Hil



Mark van den Hil is a senior business consultant with more than 16 years experience in the CPG and flower auctions market. Mark has a strong background in Logistics, Supply Chain Management and Financial Management. Mark contributed to the RFID benchmark study as key author and researcher. He interviewed a number of CPG & retail organisations in the Netherlands and the U.K.



Marcel van Nederpelt

Marcel van Nederpelt has over 15 years experience in Supply Chain Management (SCM), with a focus on Logistic Service Providers (LSP) and warehousing. As a senior business consultant he conducted various cost/benefit analyses for complex SCM issues. He has a broad knowledge of identification techniques. Marcel has led the cost/benefit analysis of this RFID Benchmark study and contributed his SCM experience.

Joris VandenBerghe



Joris VandenBerghe has over 10 years experience in transport and logistics. As a consultant he was able to analyse, design and coach the implementation of solutions for challenging projects in downstream physical distribution. Joris heads up the RFID solution Centre for LogicaCMG Belgium and gained a profound knowledge of the techniques involved. He conducted the interviews with CPG & retail organizations in Belgium.

Jörg Köster



Jörg Köster has over 20 years experience in Enterprise Resource Planning with a focus on Supply Chain Management. As a senior consultant he contributed to projects concerning software selection, software implementation and cost reduction programmes in logistic environments. Jörg conducted the interviews with CPG & retail organizations in Germany.





## Appendix 6: Sponsor profiles



Checkpoint Systems, Inc. is a multinational manufacturer and marketer of technology driven solutions for retail security, labelling, and merchandising. Checkpoint is the leading provider of radio frequency (RF)-based shrink management solutions to the global retail industry, including over half of the world's top 200 largest global retailers.

In addition to its shrink management capabilities, Checkpoint's end-to-end supply chain technology helps apparel and consumer product manufacturers and retailers brand, track and secure goods worldwide.

Checkpoint has a presence in more than 50 countries and a global network of 29 service bureaus located in the world's apparel manufacturing capitals.



At Container Centralen A/S (CC), our goal is to ensure that your logistics chain works as simply and as smoothly as possible. Our core skill is our ability to develop and maintain systems that integrate every link in the supply chain – from the manufacturer to the retailer, right to the consumer's shopping basket.

CC has a leading position in equipment pooling systems within the European flower and plant industry. At the same time, we have become respected for the way in which CC has helped the European supply chain to run more smoothly. As well as the flower and plant industry, we serve many customers in the retail food industry, including a number of the biggest supermarket chains in Europe.

**The CC Pool System**

CC uses a retail trade concept based on two principles: CC's well-acknowledged pool system with 1:1 exchange as well as products of standard dimensions.

The CC pool system enables effective circulation – and a built-in insurance. Every participant

within the system takes on just the number of units needed. And when the CC system is under way, full trolleys are simply exchanged for empty ones and vice versa. In principle no money is exchanged between the participants. We take care of trolley defects.

**The CC Units**

CC's units have been developed to conform to known European standards. This is why CC units easily fit into automated handling systems.

As consideration has been given to all aspects of the supply chain, right up to the point of display, we make it possible to set a whole new standard as to flexibility and control. This works all the way from manufacturer to the display point and can be varied throughout the day or week with minimum effort.

**Contact Us**

For more information, please contact us at:  
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 Website: [www.container-centralen.com](http://www.container-centralen.com)



Euro Pool System is the European market leader for returnable packaging and has more than thirty years of experience in supplying logistical services. Next to the head office, which is based in the Netherlands, the company has six branch offices in Germany, France, Spain, Italy, the Benelux and Czech Republic. With an extensive depot network all over Europe, Euro Pool System guarantees its clients to have always sufficient rigid and foldable containers available.

Being a partner in supply and return logistics, the pool organisation offers its customers tailor-made solutions for transport, delivery, washing



and sorting out of trays and pallets. In order to investigate where a reduction of costs could be possible, the company assists and advises its relations in analysing all costs throughout the supply chain, derived from logistics, packaging and waste management.

Read more about Euro Pool System, its products and services on: [www.europoolsystem.com](http://www.europoolsystem.com).



Intermec Technologies is a leader in global supply chain solutions and in the development, manufacture and integration of wired and wireless automated data collection and mobile computing systems. The company's products and services are used by customers in many industries to improve productivity, quality and responsiveness of business operations, from supply chain management and enterprise resource planning to field sales and service.

Key products within the Intermec range include hand-held computers, pen tablet mobile computers, vehicle mount terminals, hand-held terminals and entry-level hand-held terminals. Intermec's data capture solutions include fixed, handheld or cordless applications, featuring advanced reading capabilities and OEM scanning modules. Intermec's wide range of printers and media include the Intermec smart printers, programme solution printers, and wireless and ethernet connections.

Based on a common architecture, the Intermec product range offers class-leading ruggedness, performance and ergonomics. It also incorporates the latest technologies including imaging, wireless printing and communication via Bluetooth, GPRS and 802.11b for real-time, mobile data acquisition.

Intermec's Intellitag RFID product range includes tags as well as fixed and mobile readers for passive UHF technology. Intermec is fully committed to standards in the RFID arena, currently offering ISO 18000-6 read/write technology for across all ITU regions. As well, Intermec is also

a full member of EPCGlobal and co-chair of the UHF Gen 2 (C1G2) specification committee, and will be offering EPC compliant products this year.

The combination of RFID with traditional automatic data capture, mobile computing, printing and a proven track record in implementing solutions for many customers means that you can Expect More™ from Intermec.



Headquartered in Kyoto, Japan, OMRON corporation is a global leader in the field of automation. Established in 1933 and headed by President and CEO Hisao Sakuta, Omron has more than 23,000 employees in over 35 countries working to provide products and services to customers in a variety of fields including industrial automation, electronic components, social systems (ticket vending machines, cash dispensers, and traffic control), and healthcare. The company is divided into five regions and head offices are in Japan (Kyoto), Asia Pacific (Singapore), China (Shanghai), US (Chicago) and Europe (Amsterdam). For more information, visit Omron's Web site at [www.omron.com](http://www.omron.com).

In the field of RFID Omron is an active player since the 80's. Omron develops and produces RFID hardware and labels in LF, HF and UHF frequency bands. Omron has been involved with many projects in the RFID field with companies like Metro/Kaufhof, BA and Sainsbury's. Omron cooperates with partners to make complete solutions.

The latest news is that Omron has developed an RFID reader/writer compatible with both UHF (super-high frequency) and HF (13.56 MHz) frequency bands. In addition, Omron has also developed a UHF band IC tag that utilizes proprietary IC chip ultrasonic bonding technology. This newly developed RFID reader/writer, is capable of communication with IC tags conformed to EPC and ISO (18000-6, 18000-3) standards.





For more information on RFID products take a look at [www.omron.com/card/rfid](http://www.omron.com/card/rfid) or contact your local representative.



CEO's, CFO's, directors and managers make decisions on a daily basis, which have an influence in the organization's direction in the short term and continue to have a long-term impact.

SAS delivers software whereby information extracted from company information systems can be utilized to provide valuable decision-making insight when making these critical decisions.

SAS, established, in 1976 is the worlds largest privately held software company. More than 60% of all companies listed on the Euronext stock market are SAS customers.

SAS invests 32% of revenue in Research and Development (nearly twice the industry average). This is one reason why SAS continues to be an innovative leader in the Business Intelligence area over a period of 25 years.

SAS employs nearly 10,000 people located in over 200 offices spanning the globe, whereby 100 employees.

In more than 200 offices spanning the world, nearly 10,000 people are employed by SAS, whereby 100 people are located in the Netherlands.

#### SAS technology

SAS technology offers an integrated, open and scalable architecture, capable of harnessing and delivering detailed company knowledge (Business Intelligence). All SAS products and solutions are built on this platform-independent foundation.

#### SAS solutions

SAS utilizes operational system as a foundation for all SAS solutions. A layer of decision-making analytical applications is deployed on top of this

foundation. This results in a single source of information required for implementation of a complete, enterprise-wide, analytical knowledge strategy. The resultant areas of expertise can be categorized as: Financial Intelligence, Customer Intelligence, Supply Chain Intelligence Performance Management, Web Analytics



ZETES, an integrator offering a strong added value (advice, project management, implementation ...), takes up a European market leader position in the fields of automatic identification of goods, authentication of people and wireless networking.

Our solutions are implemented in various sectors of activity: industry, retail, transportation, logistics, distribution, health care, finance, telecommunication, public services... They are mainly based on following technology:

- bar code
- RF (Radio Frequency)
- voice recognition
- chip card (manufactured and personalised in our own production unit).

In the field of the identification of goods, ZETES provides solutions that are aimed at the optimisation of the supply chain and the automation of the general services of his customers, in interaction with their own systems.

Built on strong local presence, because we want to be close to our customers, our leadership position in Europe is based on the sharing of expertise and skills between our various European entities and a line of products and services that is at the forefront of technology.

With over 450 people, the ZETES group recorded a consolidated turnover of euro 100+ million in 2003. ZETES companies are located in following countries: Belgium, The Netherlands, Germany, France, Spain, Portugal, United Kingdom and Ireland.

