



European passive RFID Market Sizing 2007-2022



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Our diversified portfolio of products, solutions and technologies includes the GS1 System of standards (the most widely used standards system in the world) as well as GS1 BarCodes, GS1 eCom, GS1 GDSN, EPCglobal and Traceability. GS1 also offers a wide range of services, including training, certification, technical support, and implementation advice.

GS1 operates in more than 20 industries and sectors in 104 countries, and addresses all aspects of the supply chain, enabling a million companies of all sizes to execute more than five billion transactions a day. For more information, visit www.gs1.org.

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About the BRIDGE project

BRIDGE (Building Radio frequency IDentification solutions for the Global Environment) is an Integrated Project funded by the European Commission. The objective of the BRIDGE project is to research, develop and implement tools to enable the deployment of RFID and EPCglobal Network applications. The project will develop easy-to-use technological solutions for the European business community including SMEs, ensuring a basis for collaborative systems for efficient, effective and secure supply chains.

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Executive Summary

It is now three years since Wal-Mart and Metro announced ambitious plans to implement UHF RFID technology in their supply chains. These initiatives created a belief by many in the RFID industry that short-term growth would be driven by pallet- and case-level tagging.

Between November 2006 and February 2007 LogicaCMG conducted a study on behalf of GS1 to forecast the market for passive RFID in Europe for the next fifteen years. This study paints a very different picture for RFID adoption in Europe. Based on input from over 80 companies – including many European early adopters of RFID – we conclude that UHF RFID is still poised for significant growth in Europe. Most growth however, also in the short term, is coming from tagging of high-value items, instead of pallet-level or case-level tagging.

This study was conducted as part of the BRIDGE research project and focused on the use of passive RFID to track physical objects. Other applications for passive RFID, such as contactless smartcards and car clickers, are not included in our forecasts. We analysed the vertical markets that we believe to be most promising for passive RFID: retail & consumer goods, aviation, pharmaceutical & healthcare, automotive, and postal & express.

In this study we forecast the number of tags that will be purchased annually, the number of locations that will deploy RFID readers, and the total number of readers at these locations. Our forecast until 2022 is given below:

	2007	2012	2017	2022
Total number of tags purchased annually (in Millions)	144	3.220	22.400	86.700
Total number of locations with RFID readers	2.750	30.710	144.000	453.000
Total number of RFID readers deployed	7.630	176.280	1.161.800	6.268.500

Based on our analysis we predict that in five years more than 170,000 passive RFID readers will be deployed in Europe at 30,000 locations. These readers will process a total of 3 Billion tags. These numbers will grow significantly until 2022, when we expect more than 6 Million readers to be operating at 450,000 locations, with 86 Billion tags purchased annually.

We believe these numbers to be conservative, as they only represent a small percentage of the total potential number of objects that can be tagged. For example, our forecast is based on the estimation that in 2012 2% of all items in retail will be tagged. In 2022 we forecast that roughly 25% of all non-food items and 5% of all food items in retail will be tagged. If we experience a technology breakthrough in the next fifteen years that would reduce the cost of an RFID tag to less than one cent, these number could increase dramatically. In particular the number of tags on food items could grow to hundreds of Billions.

Other key findings of our research:

- European RFID implementations in supply chain management have been hindered by technical challenges. These include issues with the current European regulations, which make it difficult to use many readers in close proximity.
- High-value item-tagging will remain the largest opportunity for RFID tag and reader volumes. In the short term we expect to see significant growth in fashion and apparel, cultural goods (DVD's, books etc) and consumer electronics. In these categories RFID is helping to improve inventory management in the store, which may result in less stock outs.
- For many RFID applications it will probably take another two-three years before the market will really take off. This is due to technical issues, price levels that are prohibitive for the business case, or discussions on the distribution of costs and benefits in open supply chains.
- In the long term we expect hardware costs to come down dramatically. This is due to a combination of technical innovations and economies of scale. A passive RFID reader may cost 200 Euros, and tag prices may come down to a few Euro cents. A potential breakthrough in chipless technologies may even result in tag prices of less than 1 Euro cent (although our forecasts are more conservative and not based on this assumption).
- Retail & consumer goods will remain the largest market in terms of volumes for RFID tags and readers, accounting for approximately two-thirds of the total market volume, both short term and long term.
- After retail, the postal & express market provides the most potential. In the short term this market will focus on areas such as returnable transport items, but longer term it is likely to adopt RFID in its core processes on parcels and mail.
- In aviation RFID will be used for a wide range of applications. In 2007 we expect the first large-scale implementations in Europe in baggage tracking, and this will continue to grow in the future.
- In the next five years we do not expect RFID to be widely used in Europe against counterfeiting of drugs. Instead, we expect the pharmaceutical industry to focus on 2D barcode implementations in the near future. More longer term, the industry may change to RFID.
- UHF will be the dominant frequency for the tracking of physical objects, with HF being used in a number of niche markets such as library books.

In conclusion, RFID is developing very differently from the way most people envisioned a few years ago. And in five years from now we may again discover that RFID adoption has not developed as we predicted in this study. However, this uncertainty only relates to the speed of adoption across the various RFID applications.

There is no doubt that performance will continue to improve and prices will continue to come down. It seems certain that in the future passive RFID will become an integral part of doing business in Europe, resulting in Millions of readers that read Billions of tags each year.

Introduction

One of the reasons RFID is such an exciting innovation is the almost unlimited number of business applications. A recent report by Gartner Research analysed 99 different applications across 13 vertical markets; numbers that clearly illustrate the enormous potential for RFID technology.

In this study we estimate the market for passive RFID in Europe, focusing on the identification and tracking of physical objects. In summary, it includes the applications that may use the EPCglobal Generation 2 standard. This means that the use of RFID in contactless smartcards, such as in public transport tickets and personal identification documents, is not in scope of our research. Applications based on active RFID are also not included in our analysis.

Methodology

This study was conducted between November 2006 and February 2007 on behalf of GS1 by a team of LogicaCMG consultants in UK, France, Belgium and the Netherlands. Input consisted of desk research, a web survey, and in-depth interviews.

- **Desk research:** Our desk research covered two main areas: industry research and RFID technology research. In our industry research we analysed relevant statistical data, such as the annual number of baggage items in aviation, and the number of retail stores in Europe. Our RFID technology research covered existing research reports from leading analysts, such as IDTechEx, Gartner Research, Forrester Research and Datamonitor.
- **Web survey:** A web survey was sent by GS1 to its member organizations and to members of the EPCglobal European Adoption Program. The questions in the survey focused on the current and future use of RFID technology. We received more than 70 responses to the survey, mainly from end users.
- **Interviews:** More than 15 in-depth interviews were conducted with end users and industry experts between December 2006 and January 2007.

Our methodology for analysis was based on the following framework:

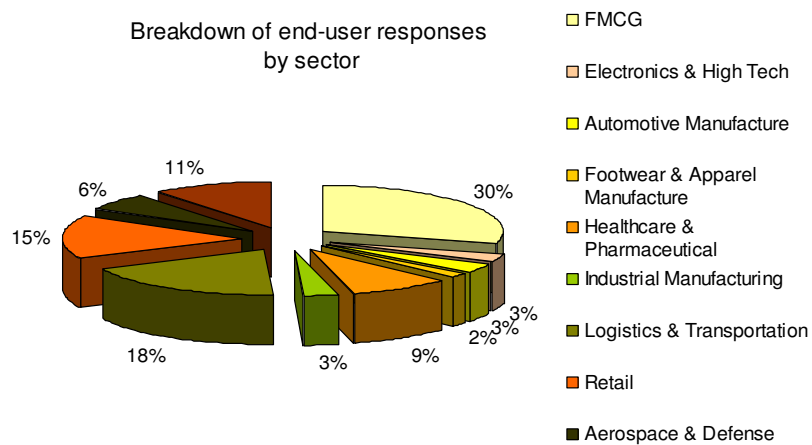
- First we identified the vertical markets on which to focus. These included:
 - retail and consumer goods,
 - pharmaceutical and healthcare,
 - automotive,
 - aviation,
 - postal and express.
- For each vertical market we identified and quantified the physical objects that may be identified and tracked with RFID technology in the future, for example pallets in the retail supply chain. We also identified and quantified the potential locations where RFID may be deployed, such as airports and retail stores.
- Based on the desk research, web survey and interviews we identified the main business drivers for RFID adoption, as well as the main

obstacles. This analysis resulted in RFID adoption scenarios, which estimate the percentage of objects that will be tagged from 2007 until 2022. These scenarios also forecast the percentage of locations that will be equipped with RFID readers, and the average number of readers at these locations.

- Based on desk research we added the data from other markets, such as library books and animal tracking.

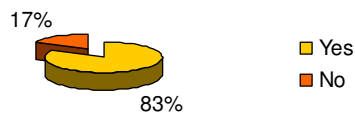
Interview and Survey Results

Our web survey and interviews provided input from approximately 50 end user companies. These companies included many European early adopters of RFID technology, from a range of industry sectors. The table below provides a breakdown per sector:

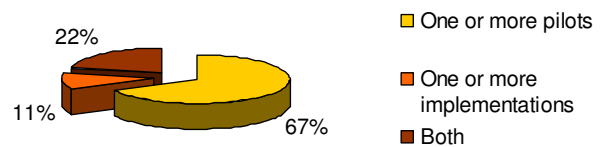


The vast majority of end users that participated in this study have gained experience with passive RFID technology in the last few years. And of these companies with experience, about one third indicates that they have started at least one implementation.

Does your company have experience with passive RFID?

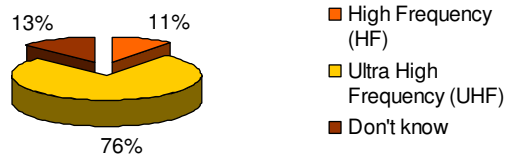


Experience of passive RFID technology



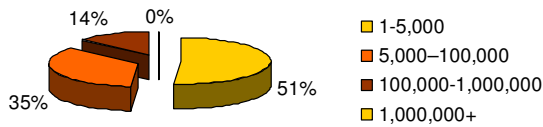
Ultra-High Frequency (UHF) has been used in most of these pilots and implementations:

Main frequency of tags bought

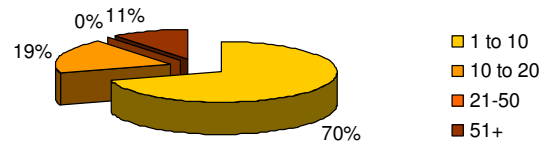


In our survey and interviews we asked end-users how many tags and readers they had purchased in 2006, and how many they plan to purchase in 2007.

Volume of passive tags bought per company in 2006

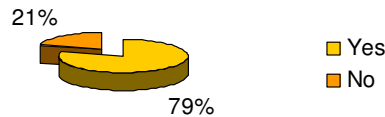


Number of RFID readers bought per company in 2006

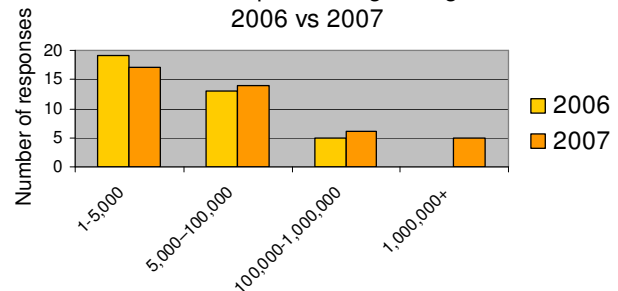


These questions indicate that most end users focused on pilots in 2006. Most companies purchased less than 5000 tags in 2006, and none of the end users we interviewed purchased more than 1 Million tags. We find a similar result in the number of readers purchased: 70 percent purchased less than 10 readers.

Investment in RFID in 2007?



Volume of passive tags bought 2006 vs 2007



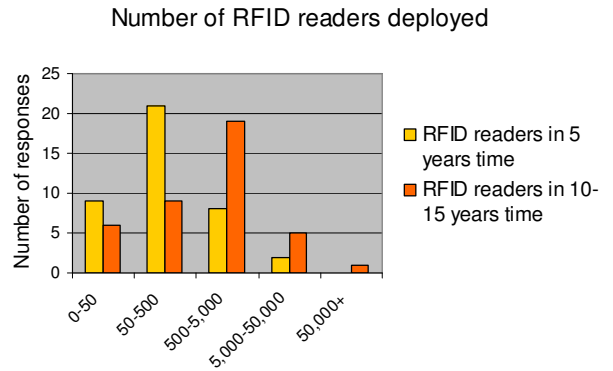
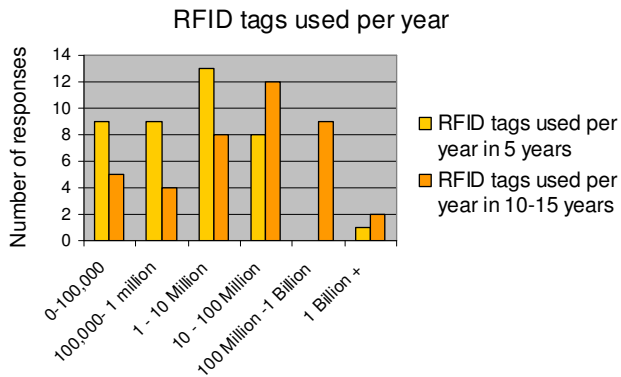
In 2007 almost 80% of end users will invest in RFID, and average volumes for both tags and readers are increasing compared to 2006. This is mainly driven by a small number of companies that will purchase more than 1 Million tags and more than 50 readers, which indicates large scale implementations. We expect these implementations in 2007 to be in baggage tagging in aviation and item-level in retail.

We also asked participants about their views on the longer term prospects for RFID within their companies. Of course, this is difficult in a rapidly

changing world. 15 years ago probably nobody would have predicted the impact of the Internet or mobile phone. We may experience similar breakthrough technologies in the next fifteen years. Nevertheless, the combined input from 50 end users provides the best possible view on the longer term trends for RFID usage.

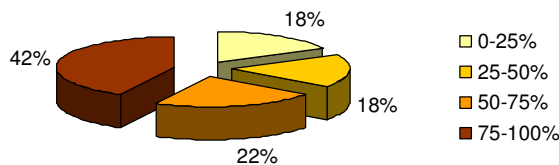
We asked participating companies to predict the number of tags used per year and the number of readers deployed in 5 years and 10-15 years from now. The answers are shown below, and clearly indicate growth. Between today and five years from now volumes for tags and readers are increasing significantly at most companies, and this trend will continue.

We also see that answers vary significantly between individual companies, especially in the number of tags used per year. This is partly based on different company characteristics, but also based on different views on future developments. In 10-15 years a significant amount of companies expects to use more than 100 Million tags per year, but there are also companies that expect to use less than 100,000 tags.



Finally, we asked participants what percentage of all objects they expect to be tagged in 10-15 years from now. 42% of the respondents indicated to expect that at least 75% of all objects they process will be tagged at that time.

What percentage of all objects do you expect to tag in 10-15 years?



General Outlook

Status of RFID Today

Clearly the RFID industry has made significant steps toward maturity in recent years, especially with the availability of the EPCglobal Gen 2 standard.

At the same time we see that the use of RFID has not grown as rapidly as many had anticipated, especially in open supply chain applications. Many end users are conducting RFID pilots today, but the number of companies that have moved to full-scale implementations remains small. This is caused by a range of issues:

- The maturity of passive RFID technology is still not sufficient for many applications. It still requires significant effort to develop solutions that meet specific requirements. Using passive RFID for baggage tracking for example requires different tag and reader design from tracking pallets in a warehouse. It simply takes time for the industry to develop these application-specific solutions.
- European regulations make it difficult to use many UHF readers in close proximity. This has clearly been a major issue for companies such as Tesco and Metro in their supply chain implementations.
- Current implementation costs remain prohibitive for many business cases. Despite recent cost reductions, especially in tag prices, many business applications will only take off at lower hardware prices.
- The distribution of costs and benefits between companies in an open environment remains complex. This has clearly been a problem in the retail and consumer goods supply chain. But it is also an issue in aviation, where airlines and airports need to find an investment model for RFID on baggage that benefits all stakeholders.

In 2007 we will see large-scale implementations in a number of applications. This includes high-value items in retail, such as apparel and books. In aviation we will see the first major European implementations of baggage tracking, for example at Amsterdam Airport Schiphol. Additionally a number of more mature applications will continue to grow, for example the use of RFID on library books.

We provide the following forecast for the use of RFID in 2007 per vertical market:

	Number of tags (in millions)	Number of locations with RFID	Number of readers deployed
Retail & Consumer Goods	62	646	1.744
Aviation	10	69	366
Pharmaceutical & Healthcare	9	111	181
Automotive	6	402	1.402
Postal & Express	21	123	488
Other	36	1.400	3.450
Total	144	2.750	7.631

Outlook for 2012

Between 2007 and 2012, we expect significant growth in the passive RFD market. We believe there will be a tipping point in two to three years, when many of the technical issues will be resolved. At that time price levels will also have come down further.

Retail and consumer goods will remain the largest market, especially in tag volumes. For example, we expect 0,5% of all food items to be tagged in 2012. This will be mainly on fresh products such as meat, where it is important to track the best-before-date. This 0,5% of food items alone results in 500 Million tags in 2012. This number is equal to the total number of all baggage items in aviation in Europe per year. For 2012 we provide the following forecast per vertical sector:

	Number of tags (in millions)	Number of locations with RFID	Number of readers deployed
Retail & Consumer Goods	2.270	11.590	70.570
Aviation	60	280	5.930
Pharmaceutical & Healthcare	350	2.770	12.600
Automotive	50	4.120	28.250
Postal & Express	270	950	2.950
Other	230	11.000	56.000
Total	3.220	30.710	176.280

Outlook for 2017 and beyond

Of course it is impossible to provide completely accurate long-term forecasts for the use of a technology that is so rapidly evolving. Despite this, current developments provide significant insights to what the future may bring.

Just like any other market, the market for RFID is price sensitive: as prices go down, demand will increase. Over the last few years some industries have been looking at RFID, only to conclude that current price levels are prohibitive for the business case. For example, archiving of important documents, mail and parcel tracking in postal & express, and tracking of low-value food items in retail. Would these industries adopt RFID at significantly lower price levels? The answer is yes, as RFID can provide substantial benefits over other identification technologies. And if these markets adopt RFID, they will consume significant volumes of tags and readers.

So the question is whether the costs for RFID tags and readers can be reduced significantly in the future. And again the answer is yes. This is partly based on economies of scale: as volume will steadily increase in the future, the price per tag and reader can be reduced. But real breakthroughs in price levels will also be driven by technical innovations. Current R&D efforts provide some insights into what we may expect ten years from now. On the tag side, the most promising development will be in chipless tags.

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Both start-ups and established market players are currently investing millions of euros in the development of printed Thin Film Transistor Circuits. According to Raghu Das, CEO of IDTechEX, these chipless tags may have a price of less than 1 cent in 2017, especially when they are integrated into packaging. If this will happen, it will result in significant growth for RFID volumes in a range of markets.

In our forecasts for 2017 and 2022 we have remained fairly conservative. For example, we forecast that in 2017 only 1% of all food items will be tagged, growing to 5% in 2022. For 2017 we provide the following forecast:

	Number of tags (in millions)	Number of locations with RFID	Number of readers deployed
Retail & Consumer Goods	13.700	59.900	502.700
Aviation	300	1.100	51.000
Pharmaceutical & Healthcare	1.700	11.900	70.200
Automotive	200	9.000	125.900
Postal & Express	3.500	3.600	15.100
Other	3.000	58.500	397.000
Total	22.400	144.000	1.161.800

Finally, we provide the following forecast for 2022:

	Number of tags (in millions)	Number of locations with RFID	Number of readers deployed
Retail & Consumer Goods	56.100	206.600	3.440.500
Aviation	500	1.500	160.900
Pharmaceutical & Healthcare	6.700	40.600	208.000
Automotive	500	18.700	536.900
Postal & Express	12.600	13.600	52.300
Other	10.300	172.000	1.870.000
Total	86.700	453.000	6.268.500

Outlook per Vertical

Retail & Consumer Goods

Retail & Consumer goods will remain by far the largest market in volumes for UHF RFID hardware. Both today and in the future, we expect this market to account for roughly two-thirds of the total volume of RFID tags and readers.

Despite the initial excitement about pallet- and case-tagging in supply chain management, the main volumes are coming from item-level tagging.

In the United Kingdom Marks & Spencer is reporting to be obtaining significant benefits by attaching RFID tags to certain types of apparel. Improved inventory management at the store level is helping to prevent stock outs and increase sales. Similar benefits have been found by Dutch book retailer BGN. In October 2005 BGN's CIO visited an RFID conference in Amsterdam. He quickly became convinced about the business value of RFID, and seven months later RFID was fully implemented at one of BGN's major bookstores. The RFID tags are applied to the books by the main book distributor in the Netherlands, and BGN is planning to roll out RFID to all its stores in the near future.

At the same time, the supply chain implementations from Metro in Germany and Tesco in the UK have not progressed according to plan. Both projects have experienced technical challenges, including issues caused by the current European regulations. Nevertheless, both companies remain convinced about the potential business value and committed to implement RFID in their supply chains.

Returnable transport items, such as plastic totes and roll cages, remain a focus area for the European retail supply chain. The EPCglobal Gen 2 standard has been very important, as it has made investments for tags on returnable transport items significantly more future proof. On these items it is much more cost effective to mount a tag into the item during manufacturing, than to retrofit an RFID tag onto an existing product. As a result we expect new transport items to be equipped with RFID. But as these items have a life expectancy of 5-7 years, it will take considerable time before all returnable transport items will be RFID tagged.

Even with conservative estimates the volumes in retail are very large. For example, in our calculations we have assumed that in 2022 only 5% of food items will be tagged. This percentage gives a volume of 31 Billion tags annually. Within the next fifteen years we may see breakthroughs in technology that may result in mass adoption on individual food items, such as chipless tags that can be integrated into packaging. If this will happen, the volume of tags on food items can reach more than 500 Billion annually.

Our forecast for the retail & consumer goods industry is summarised below:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On food items	0	520	5.200	31.700
On non-food items	26	960	5.000	12.400
On cases	34	760	3.300	11.500
On pallets	2	40	200	500
Total RFID tags	62	2.270	13.700	56.100
Locations with RFID readers	650	11.590	59.900	206.600
Total number of RFID readers	1.740	70.570	502.700	3.440.500

Aviation

Aviation is one of the industries on which RFID technology will have a significant impact. The number of potential applications is large, ranging from tracking **catering trolleys** and other in-flight items to **baggage tracking** and tracking assets like **cargo containers**. Historically, it has been difficult to manage these items, as they are constantly moved around in a very dynamic environment. This provides a perfect opportunity for RFID. The main obstacle for large-scale adoption of RFID is standardization in this open environment.

Out of these applications baggage tracking has probably received most industry attention. IATA, the global airline association, agreed on a global standard in 2005, and is actively supporting RFID on baggage as part of its Simplify the Business initiative. Implementations at Hong Kong Airport and Las Vegas Airport have confirmed the potential. At the same time, a number of airlines remain sceptical about the business case, which is mainly based on a reduction in lost baggage. Different pilots have also experienced some technical issues. The most pressing issue today is that RFID readers should only read one baggage tag at a time. A unique identification of baggage is required to instruct the baggage handling system. In 2007 we expect to see the first large-scale implementations in Europe, for example at Amsterdam Airport Schiphol, and within five years we expect that 10% of all baggage in Europe will be tagged. This percentage will grow to 75% in 2022.

Aircraft maintenance is another business area that will benefit from RFID technology. Boeing is working with suppliers of the new Dreamliner model to incorporate RFID tags on many aircraft components. These will be UHF RFID tags that will store important information during the lifecycle of the component. Although the benefits from RFID are clear, the full roll-out will not happen overnight. As many components have a lifetime of approximately 30 years, it will take many years before RFID will be implemented by the entire industry.

Our forecast for the aviation industry is summarised below:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On baggage	10	56	249	481
On assets	0	0	1	7
On in-flight items	0	0	1	8
On aircraft components	0	0	1	31
Total RFID tags	10	60	300	500
Locations with RFID readers	70	280	1.100	1.500
Total number of RFID readers	370	5.930	51.000	160.900

Pharmaceutical & Healthcare

There has been a lot of debate in recent years about the use of RFID to prevent **drugs counterfeiting**. This was partly initiated by the FDA (Food and Drug Administration) in the United States, which in 2004 encouraged pharmaceutical companies to use RFID on individual drug items to authenticate products. This provided a major push for RFID adoption in the pharmaceutical industry, but discussions about the preferred frequency (HF or UHF) quickly took most of the attention. In late 2006 the FDA backed down from its RFID endorsement, citing a number of open issues.

In Europe in the mean time, the support for RFID against drugs counterfeiting remained small. The industry is clearly pushing the mass serialization of drugs, but it appears to support the 2D barcode as the preferred identification technology. Of course, the 2D barcode can be printed on the packaging, and costs are lower than for RFID tags. More longer term we believe that RFID will provide benefits over 2D barcodes, especially to track drugs in the supply chain. And as costs come down, potentially with chipless tags in the future, we expect a major role for RFID in drug authentication, also in Europe.

The pharmaceutical and healthcare industry will also benefit from RFID in a number of other applications. The use of RFID to better manage different **assets in a hospital environment** is quickly gaining momentum, ranging from beds to wheelchairs and even patients. Some of these applications will be based on active RFID solutions, but passive RFID is also likely to play a role in these applications. And volumes are likely to increase as the adoption will also move to care homes in the future.

Finally, RFID will be used to identify and **track medical samples**, such as test tubes and blood bags. Of course, identification is critical on these items, and RFID provides some benefits over other identification technologies.

Our forecast for the pharmaceutical and healthcare industry is summarised below:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On hospital assets	2	98	190	320
On samples	1	8	30	40
On drugs	5	246	1.500	6.380
Total RFID tags	9	350	1.710	6.740
Locations with RFID readers	110	2.770	11.900	40.600
Total number of RFID readers	180	12.600	70.200	208.000

Automotive

The automotive industry has been using RFID technology for many years, mainly with proprietary solutions in closed applications. For example, active RFID is being used to locate cars in **yard management** applications, and passive RFID (often with low-frequency) is used for **quality control in manufacturing plants**. These applications are likely to grow in the future, but we have not included these applications in our forecasts, as they are not focused on identification and tracking of physical objects with passive RFID.

What we have analysed is the use of RFID in supply chain management applications. Most car assembly plants operate on just-in-time principles, with extremely low inventory levels. This requires excellent logistical processes, and RFID can certainly play a role in this. In recent years there have been a number of RFID initiatives in which suppliers and car manufacturers are working together to track the flow of goods. **Returnable transport items**, such as containers and plastic totes, are widely used in these processes, and so most RFID projects involve these items. This is likely to grow significantly in the future.

A different application is the use of RFID to **identify and track vehicles**. This application is similar to the initiatives from Boeing in aviation, to identify and track a component during its lifecycle. RFID can be used in a similar way to store information about the history of a vehicle. This may be used by car dealers and garages, for example during maintenance or when the car is sold.

Our forecast for the automotive industry is summarised below:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On returnable transport items	6	45	187	490
On vehicles	0	1	2	5
Total RFID tags	6	50	200	500
Locations with RFID readers	400	4.120	9.000	18.700
Total number of RFID readers	1.400	28.250	125.900	536.900

Postal & Express

Postal and Express is a market with huge potential to gain benefits from using RFID technology. Both UPS and DHL, two of the global leaders in this industry, have been active members of EPCglobal for many years. The industry has also some relatively mature applications, such as **process monitoring** by the International Post Corporation (IPC). This system monitors the quality of service at national post operators. It is based on a network of RFID readers that track active RFID tags in sample envelopes.

The Spanish Post organization Correos has recently implemented a similar application to monitor its internal processes based on passive UHF RFID technology. More than 300 UHF readers have been installed at sorting centres across Spain. The Spanish government has allowed Correos to use UHF protocols and power levels similar to those of the United States.

Other post operators have piloted UHF RFID to improve **asset management of returnable transport items** such as roll cages. At this stage it remains unclear whether the performance of passive RFID provides sufficient performance to meet the business requirements, or if active solutions will be preferred. This debate may slow down adoption for the next few years.

The early involvement from DHL and UPS created a belief in the industry that RFID might be globally implemented for **parcel tracking**. However, progress in this area in recent years has been slow. This is not surprising: both DHL and UPS already use barcodes to track parcels, and RFID implementations in the core processes require significant additional investments. Today it seems unlikely that the express business will move to large scale implementations in their core processes in the next few years, except in markets where barcodes are not widely used. UPS for example has publicly declared that RFID does not provide enough additional benefits over its existing bar code systems, and therefore it will not implement RFID in its core parcel business in the foreseeable future. More longer term however, RFID seems to be the preferred option for identification and tracking of parcels.

When we look to 2017 and beyond, we expect RFID also to be used **to track mail**, for example when a high quality of service is required.

Note that we did not include a separate category logistics to prevent double counting of tags and readers. The numbers for cases and pallets in supply chain management are already covered in the different vertical markets, such as retail and automotive.

Our forecast for the Postal & Express industry is summarised below:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On parcels	20	265	780	2.900
On mail	0	0	2.750	9.600
On returnable transport items	1	2	10	30
Total RFID tags	21	270	3.500	12.600
Locations with RFID readers	120	950	3.600	13.600
Total number of RFID readers	490	2.950	15.100	52.300

Other Markets

As stated earlier, RFID will be used in countless applications. Besides the vertical markets that we analysed in detail, RFID will also be used to track physical objects in a range of other markets. We have forecasted a number of these applications.

In fact, the use of RFID to track **animals** is already a very mature RFID application. RFID has been used for many years in this industry and is now a proven solution. Driven by food safety concerns it will continue to grow in the future, also in Europe. The same is true for RFID to track **library books**. Using HF technology, proven solutions are available today, and more and more libraries in Europe are implementing RFID to improve customer service and reduce costs.

Defence is another market that has received a lot of attention from the RFID industry. The complex logistical operations with high-value items provide an environment in which RFID can provide significant value. In the United States the Department of Defense (DoD) has already implemented a global system to track containers with active RFID. And in 2004 the DoD also announced that it would ask its suppliers to use passive RFID labels on all delivered items. However, it appears that the implementation of passive RFID is progressing slowly, and there is currently no evidence that European defence organisations will implement passive RFID in the near future. More longer term however, there is little doubt that passive RFID will be used to track military items.

Finally, we have forecasted to use of RFID to track **archived documents**. In the short term the volumes for this application will remain modest, as tag prices are prohibitive for most implementations. However, as tag prices will come down in the future, this market has a very large potential. Therefore we expect this market to grow significantly in 10-15 years.

Our forecast for the other markets is summarised below:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On animals	12	25	125	150
On library books	22	55	80	120
On military items	1	100	800	2.000
On archived documents	1	50	2.000	8.000
Total RFID tags	36	230	3.000	10.300
Locations with RFID readers	1.400	11.000	58.500	172.000
Total number of RFID readers	3.450	56.000	397.000	1.870.000

Appendix A:
Forecast for 2007 - 2022

Forecast for 2007 by vertical market:

	Number of tags (in millions)	Number of locations with RFID	Number of readers deployed
Retail & Consumer Goods	62	646	1.744
Aviation	10	69	366
Pharmaceutical & Healthcare	9	111	181
Automotive	6	402	1.402
Postal & Express	21	123	488
Other	36	1.400	3.450
Total	144	2.750	7.631

Forecast for 2012 by vertical market:

	Number of tags (in millions)	Number of locations with RFID	Number of readers deployed
Retail & Consumer Goods	2.270	11.590	70.570
Aviation	60	280	5.930
Pharmaceutical & Healthcare	350	2.770	12.600
Automotive	50	4.120	28.250
Postal & Express	270	950	2.950
Other	230	11.000	56.000
Total	3.220	30.710	176.280

Forecast for 2017 by vertical market:

	Number of tags (in millions)	Number of locations with RFID	Number of readers deployed
Retail & Consumer Goods	13.700	59.900	502.700
Aviation	300	1.100	51.000
Pharmaceutical & Healthcare	1.700	11.900	70.200
Automotive	200	9.000	125.900
Postal & Express	3.500	3.600	15.100
Other	3.000	58.500	397.000
Total	22.400	144.000	1.161.800

The forecast for 2022 by vertical market:

	Number of tags (in millions)	Number of locations with RFID	Number of readers deployed
Retail & Consumer Goods	56.100	206.600	3.440.500
Aviation	500	1.500	160.900
Pharmaceutical & Healthcare	6.700	40.600	208.000
Automotive	500	18.700	536.900
Postal & Express	12.600	13.600	52.300
Other	10.300	172.000	1.870.000
Total	86.700	453.000	6.268.500

Appendix B:
Forecast by vertical market

Forecast for the retail & consumer goods industry:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On food items	0	520	5.200	31.700
On non-food items	26	960	5.000	12.400
On cases	34	760	3.300	11.500
On pallets	2	40	200	500
Total RFID tags	62	2.270	13.700	56.100
Locations with RFID readers	650	11.590	59.900	206.600
Total number of RFID readers	1.740	70.570	502.700	3.440.500

Forecast for the aviation industry:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On baggage	10	56	249	481
On assets	0	0	1	7
On in-flight items	0	0	1	8
On aircraft components	0	0	1	31
Total RFID tags	10	60	300	500
Locations with RFID readers	70	280	1.100	1.500
Total number of RFID readers	370	5.930	51.000	160.900

Forecast for the pharmaceutical and healthcare industry:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On hospital assets	2	98	190	320
On samples	1	8	30	40
On drugs	5	246	1.500	6.380
Total RFID tags	9	350	1.710	6.740
Locations with RFID readers	110	2.770	11.900	40.600
Total number of RFID readers	180	12.600	70.200	208.000

Forecast for the automotive industry:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On returnable transport items	6	45	187	490
On vehicles	0	1	2	5
Total RFID tags	6	50	200	500
Locations with RFID readers	400	4.120	9.000	18.700
Total number of RFID readers	1.400	28.250	125.900	536.900

Forecast for the postal & express industry:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On parcels	20	265	780	2.900
On mail	0	0	2.750	9.600
On returnable transport items	1	2	10	30
Total RFID tags	21	270	3.500	12.600
Locations with RFID readers	120	950	3.600	13.600
Total number of RFID readers	490	2.950	15.100	52.300

Forecast for other markets:

	2007	2012	2017	2022
RFID Tags (in Millions)				
On animals	12	25	125	150
On library books	22	55	80	120
On military items	1	100	800	2.000
On archived documents	1	50	2.000	8.000
Total RFID tags	36	230	3.000	10.300
Locations with RFID readers	1.400	11.000	58.500	172.000
Total number of RFID readers	3.450	56.000	397.000	1.870.000

Appendix C:
Forecast by hardware type

Forecast for the total number of tags by vertical market (in Millions):

	2007	2012	2017	2022
Retail & Consumer Goods	62	2.270	13.700	56.100
Aviation	10	57	250	500
Pharmaceutical & Healthcare	9	352	1.710	6.700
Automotive	6	46	190	500
Postal & Express	21	268	3.540	12.600
Other	36	230	3.010	10.300
Total	144	3.220	22.400	86.700

Forecast for the number of locations with RFID readers by vertical market:

	2007	2012	2017	2022
Retail & Consumer Goods	646	11.590	59.910	206.600
Aviation	69	278	1.100	1.500
Pharmaceutical & Healthcare	111	2.767	11.860	40.600
Automotive	402	4.123	8.960	18.700
Postal & Express	123	950	3.630	13.600
Other	1.400	11.000	58.500	172.000
Total	2.750	30.710	143.960	453.000

Forecast for the number of passive RFID readers by vertical market:

	2007	2012	2017	2022
Retail & Consumer Goods	1.744	70.570	502.670	3.440.500
Aviation	366	5.925	51.000	160.900
Pharmaceutical & Healthcare	181	12.597	70.150	208.000
Automotive	1.402	28.246	125.890	536.900
Postal & Express	488	2.950	15.050	52.300
Other	3.450	56.000	397.000	1.870.000
Total	7.631	176.280	1.161.760	6.268.500

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