

3 Current Services and Applications

This chapter gives a description of RFID services and application provided today. The first section gives an overview of the different kind of services and application. In the next section several examples of RFID applications and services are described in more details. The third section gives key information about the RFID market in general, and the final section makes a model of the RFID value chain.

3.1 Overview and classification of services and applications

3.1.1 Definitions

The terms “service” and “application” is commonly used in this report, and need to be defined. For this report the terms should be understood as described below.

Application: A software component with a specific task or function [24].

Service: A service is what is offered to the customer – what the customer pays for. A service can make use of one or more applications. It can also include additional non-software components, for instance knowledge of supply chain management, server management or billing.

3.1.2 Classification of application and services

The RFID technology is already being used for several purposes. A search on the Internet shows a great variety of services and application where RFID is a component in the technology solution. The range of applications is expected growing as the technology is becoming widely accepted and more cost effective for more applications. The list below shows a classification of typical RFID services (the list is not complete):

- Access Control
- Animal Tracking
- Asset Management
- Baggage Handling
- Product Authentication, Security
- Supply Chain Management
- Transportation
- Wireless Commerce, Payments, Toll Collection
- Sports Timing

Access control includes wireless and automated access to buildings, car parks, hotel rooms, cars, concerts/football matches, gates at airports, ski lifts, etc. The specific RFID technology used for the different purposes varies.

The main goal of Animal Tracking is to make farm management more effective. RFID is used to identify the livestock animals. Systems can then be used for tracking meat and dairy animals, valuable breeding stock and laboratory animals involved in expensive research projects. With the tags in an electronic ear tag or injected directly into the animals, farm management can be fully automated for such processes as feeding, weighing, disease management, and breeding practices.

Asset Management is a category where the purpose of RFID application is to simplify tracking of different objects and to make more effective systems for inventory management. The objects could be rental cars, valuable machines/tools, documents, and other products.

Baggage handling in the airline industry is a feat that requires identifying and tracking millions of items daily. With RFID technology smart labels are placed at each item. Live field trials have proven RFID to be more robust and reliable than the existing barcode system [25]. The system is highly reliable and economical for tracking luggage for positive passenger-to-baggage verification and reconciliation. RFID tags can be integrated with existing baggage tags, check-in desk printers, and sorting equipment. Luggage can be automatically scanned in groups, no matter the orientation of the bag or whether it is overlapped with others.

For Product Authentication and Security RFID gives new possibilities for securing products/item from fraud and theft. Products require a unique ID from an RFID tag for working properly. This makes theft of less interest. As an example from automotive, RFID technology can be used for immobilization of cars when it is tried started without the owners key (RFID tag integrated in the key). Mobile phones is another product, popular stealing, that can be secured be RFID technology.

Supply Chain Management can be done more efficient and effective by using RFID technology. Tracking, routing and return of products (for instance beer kegs or pallets) can easily be made.

For transportation and fleet management, RFID is an enabler for making more time effective transportation system and giving better customer service. Several places in Europe RFID tags have been placed on buses. Further RFID readers are placed in bus terminals, along the route and in traffic lights. This make a public transportation system that increases terminal capacities, gives better information to customers and drivers, and that can give priority to public transport vehicles in crossroads/traffic-lights.

RFID are also used for making more effective and convenient systems for commerce. Examples of such systems are wireless payments, toll collections (roads) and customer knowledge/information collection used to personalize product offers and gain loyalty. Further RFID is used for making it easier to present accessories for products and other additional information.

The last category is Sports Timing. Athletes are wearing RFID tags which makes it easy to coordinate times of thousands of persons, and give perfect information about time on interim points and finish line.

Section 3.2 contains more information about the different application. Several examples of applications and services are also presented.

3.1.3 Services of interest for Telcos

An important subject is which applications and services that are of interest for Telcos. There is of course no simple answer top this. Among others it will depend on the Telcos business scope and the business model for the service or application.

For most telecom companies, network traffic will be an interesting aspect of RFID services, and also services where telcos can play a key role. The amount of traffic in the public networks will be a result the RFID systems demand for on-line communication as well as the size of information that fleets through the networks. In the figure below, different applications and services are mapped in such a chart.

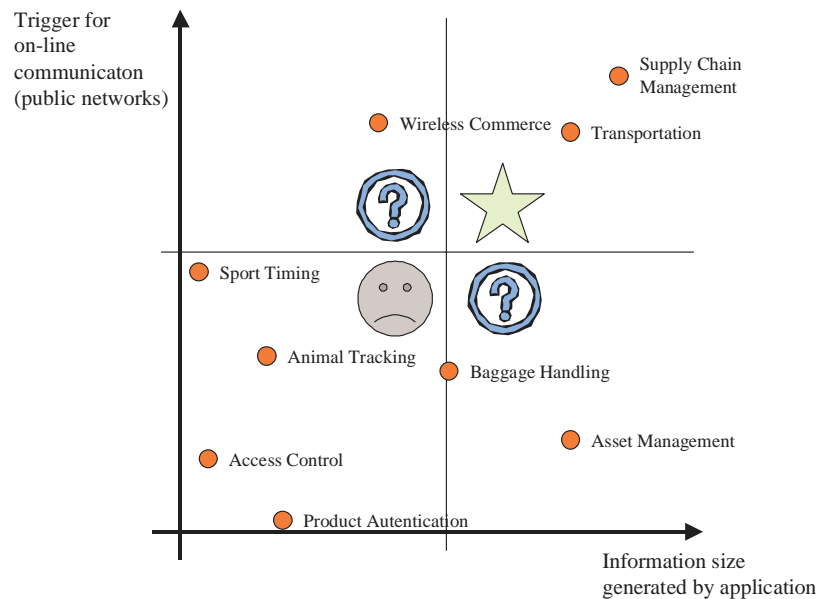


Figure 5: Classification of RFID services

Services in the upper right square will generate a lot of traffic in the public network. The services often include several actors and the information handling can be complex. These can be interesting services from a telecom operator's view.

Services in the lower left square will not generate much traffic. Most of the data will fleet through private networks. The information load will also be low. For telecom companies these services don't make great business opportunities. However, there could be other business models that can change this consideration.

The other services could be interesting. Some of them have a great need for on-line communication. Some of them generate a lot of data traffic.

The classification in the figure above does not take into account neither future services nor RFID-application for improving internal processes.

3.2 Applications and services provided today

The main purpose of this section is to give concrete examples of different RFID-services and – applications. The examples will be within the different application classes as described earlier. The descriptions will present the application in general, what the winnings are, how they work and how the RFID-technology is a central part of the system. There will also be references to additional information. The table below gives an overview of the applications and services presented.

<i>Application class</i>	<i>Name</i>	<i>Short description</i>	<i>More info.</i>
Access Control	Security Access for FedEx Parcel Couriers	RFID-system for automatic keyless entry and ignition system. Couriers wear an RFID transponder embedded within a Velcro wristband.	Section 3.2.1
Access Control	eGate - Automated boarding system	eGate is a fast lane to the aircraft, reducing the overall time for boarding. Used by Finnair.	Section 3.2.1
Access Control	Parking Access Control	Automated management of access and capacity of parking spot at Gleneagle Hospital. System reduces access time and need of guards.	Section 3.2.1
Animal Tracking	StocTraka	RFID system for more effective management of farming. The system helps the cattle producer's and feedlot operator's to maximize the performance and profitability of each individual animal.	Section 3.2.2
Asset	Document tracking	Tagging assets to help locate objects (documents,	Section 3.2.3

Management		beer kegs, etc.).	
Baggage Handling	Routing of baggage at Heathrow airport	System for identifying, sorting and tracking of baggage transported through the system.	Section 3.2.4
Product Authentication	Vehicle Immobilizer	Driver uses a transponder attached to a key ring. A reader in the ignition system. The unique ID sent to the reader allowing the vehicle to start.	Section 3.2.5
Supply Chain Management	Smart Pallet System	RFID system solves the problem of management information connected to the flow of materials through production chain.	Section 3.2.6
Supply Chain Management	Warehousing	RFID system helps employees knowing when shelves should be refilled with products.	Section 3.2.6
Supply Chain Management	Tot bin application	Product carriers can be tagged for order picking or for routing purposes to the next workstation.	Section 3.2.6
Transportation	Improving Bus Terminal Management	In Vejle in Denmark RFID system helps increasing capacity and customer service of a Bus terminal.	Section 3.2.7
Transportation	Vehicle Access System	RFID system for giving priority to some vehicles (bus, ambulance, etc.). System helps to make effective traffic systems.	Section 3.2.7
Transportation	Fleet Management	RFID used to keep overview of the fleet and reduce the necessary fleet size.	Section 3.2.7
Wireless Commerce	Prada Epicenter	RFID used in to present product information, accessories, personalizing service, etc.	Section 3.2.8
Wireless Commerce	ExpressPay from American Express	Wireless payment enabled by RFID technology.	Section 3.2.8
Wireless Commerce	Nokia, MasterCard test wireless payment	Wireless payment enabled by RFID technology.	Section 3.2.8
Wireless Commerce	Self Check out counters	Automated check out counters reducing bottlenecks at warehouses.	Section 3.2.8

Table 14: Overview of RFID application described in this section

3.2.1 Access Control and Security

Access control includes wireless and automated access to buildings, car parks, hotel rooms, cars, concerts/football matches, gates at airports, ski lifts, etc. The specific RFID technology used for the different purposes varies. This section report presents three different access control systems where RFID is the enabling technology. The systems are:

- Security Access and Convenience for Express Parcel Services (Cars)
- Automated boarding systems on airports
- Parking Access Control

3.2.1.1 Security Access and Convenience for Express Parcel Couriers

Federal Express (FedEx) is the world's largest express parcel delivery company. FedEx delivers approximately 3,2 million parcels daily and operates a fleet of more than 42 500 vehicles worldwide.

FedEx is now testing an RFID-system for automatic keyless entry and ignition system [26]. The system is being tested in 200 FedEx delivery vehicles. The company's couriers wear an RFID transponder embedded within a Velcro wristband.

The winnings will be more effective couriers and a more convenient work situation for the couriers. With RFID, FedEx delivery personnel are freed from the hassles of juggling their keys while carrying armloads of packages and are more productive along their routes (save time). If a

wristband is misplaced, its code can be purged from the system and a new code can be reprogrammed in a matter of seconds. Earlier, if a courier misplaced his keys, he had to wait for someone from a FedEx station to bring out a spare, and the vehicle had to be re-keyed at a cost of more than \$200 per incident.

The FedEx system uses RFID readers mounted at each of the four doors to the delivery vehicle and a reader mounted on the right side of the steering column near the ignition switch. When the courier places his transponder wristband within 6 inches of the readers, the transponder's code is compared to ones in the system's memory. If it is a match, the door unlocks for five seconds. The courier simply pulls on the door handle to enter the vehicle while the three remaining doors stay securely locked to prevent unauthorized entry. To start the vehicle, the courier pushes a button on the right side of the steering column. The courier pushes another button near the start button to turn off the vehicle.

All exterior door locks can be released from the inside with conveniently located buttons. A fail-safe keyed lock is maintained for the rear roll-up door in case of an electrical failure. Anti-theft features include motion detectors in both the courier and cargo compartments, and a self-contained horn. The system is programmed to ensure that the vehicle will not start until all doors are shut, and all doors automatically lock within five seconds of opening. Each FedEx vehicle is programmed using a master transponder, and can accept up to ten unique transponders. A single transponder can also be programmed to operate multiple trucks.

3.2.1.2 eGate - Automated boarding system for Finnair Plc

The purpose of the system is to perform automated passenger identification allowing automated check-in and boarding. eGate [27] provides a new service for series ticket holders and top-tier Finnair Plus members with eTickets on Finnair's domestic flights. eGate is shown in the figure below.



Figure 6: The eGate system (Source: www.ideos.fi)

The basic components of the system are the RFID transponder embedded into the Frequent Flyer Card (e.g. MultiFLYe) and the RFID reader devices integrated into the eGate. When a passenger carrying one of the above-mentioned cards walks through the eGate, the identification takes place automatically. If the passenger has a reservation for the flight the system immediately starts the check-in and boarding procedure. The passenger is then allowed to board the plane. The complete procedure happens in a few seconds.

The eGate systems have been in use in various airports in Finland since March 2002. Passengers travelling with RFID equipped identification cards can now walk through the eGate straight onto the plane without showing the card, which is automatically read. eGate is a fast lane to the aircraft. Overall boarding time can be significantly reduced, freeing staff for more profitable customer care activities. The system also provides a higher level of security. RFID cards cannot be duplicated or

tampered, and the system can easily be integrated with biometrics identification (e.g. fingerprints) for maximum security.

The data management between eGate and the airline booking system is handled by OpenId middleware.

3.2.1.3 Parking Access Control Applications

Through the use of RFID technology for access control, security managers can accurately monitor parking lot traffic, occupancy times, and even specific vehicle information [28]. RFID allows for an error-free, fast read, non-duplicatable alternative to the traditional means of site security. With a variety of transponder form factors that can be mounted on or within the vehicle, people can enter a secured area without having to open a door or a window to obtain authorization.



Figure 7: Hassle-Free Parking

Gleneagle Hospital is a concrete example of an organization that has implemented the parking access system. At the hospital the medical staff often encountered delays entering and leaving the parking garage, especially during peak hours. The hospital's 1,000 employees had to wait for attendants to manually operate the exits that created a bottleneck for staff and the paying publics. Occasionally, the situation interfered with a staff member's ability to respond to an emergency.

With the automated system, throughput was doubled, the cost of attendants was eliminated, and the car park system is error-free, which improves hospital security. The hospital's new system also promotes employee convenience, comfort and peace of mind.

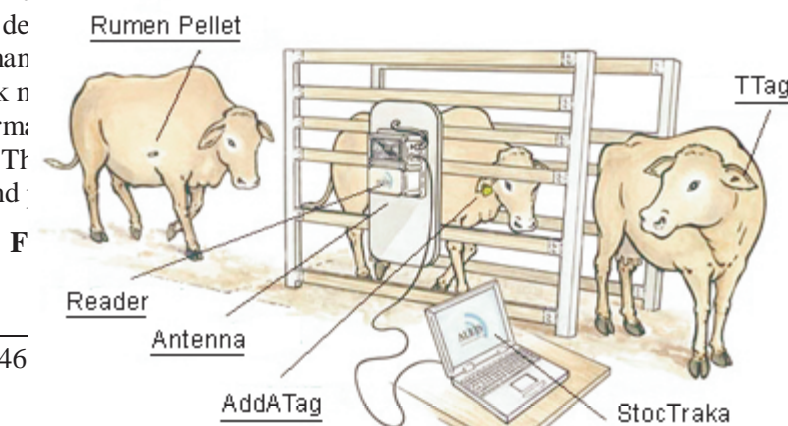
Another benefit to the hospital is in gaining valuable data about its parking facility. Besides controlling access, the reader tracks parking use by collecting data about how often each employee frequents the garage, how long cars stay parked and how many cars use the garage each month. Such information helps the hospital evaluate and manage its parking capacity.

The system uses the low frequency windshield-mount transponder that can read up to five feet.

3.2.2 Animal Tracking

RFID technology is used to identify and track valuable breeding stock, laboratory animals involved in lengthy and expensive research projects, meat and dairy animals, wildlife, and even prized companion animals. The RFID tag can be embedded under the animal's skin or attached to its ear, storing information such as owner, birth date, medical record and veterinary data that can be updated as the animal receives various forms of treatment. This RFID application eliminates lost identification tags and reduces the paperwork needed to store information about the animals.

An Australian company has developed an RFID-system called StocTraka (also European companies are developing it). It is a fully integrated stock management system. It enables producers to manage their stock more effectively. It allows operators to control their stock through to its ultimate sale. The system helps to maximize the performance and health of the animals.



The system consists of radio frequency identification devices, a remote race antenna/reader or portable reader with a user-friendly herd management software program.

All animals are tagged with a RFID tag (either attached or inserted into the animal). As tagged animals move through the race they are identified by an antenna/reader that is bolted to the race. Data collection is automated. The antenna/reader can read animals of varying heights and speed. Because it takes only a millisecond to read the identification number, 3000 animals a day can be identified and weighed. The race antenna/reader is transportable.

Animal's unique identification numbers are automatically entered to the software on a nearby computer. This software appends relevant information to a sophisticated database - and automatically provides the producer with valuable, on-the-spot feedback. The software can produce reports that profile average daily weights, health and veterinary costs, breeding, sales, feeding, profit and loss, and progeny. It can also instantly calculate the entire weight and value of a herd based on the current market price. Then an animal is sold, its full stock management history can be passed to the new owner. This ensures that the integrity of your operation remains secure at all times.

3.2.3 Asset Management

RFID technology enables applications to simplify tracking of different objects and to make more effective systems for inventory management.

RFID can be used for document tracking applications as a way to improve the management of important document files in industries like insurance and legal where the loss of such files can cause severe problems. RFID improves the tracking of documents so that files can be more quickly located and legal document workflow more easily tracked. Each file is tagged with a smart label that contains a unique ID and human readable information. The file description is entered into a database along with its tracking number. The file can be assigned certain parameters like expiration date, permitted movement, and persons authorized to see it. Over time the database can build up an audit trail of the handling and workflow history of each document file. Employees can locate a file by entering a request in their desktop PC.

Valuable assets such as Earthmoving equipments [30] and other road working equipments do go 'missing' and are very hard to track down, when they are it is sometimes even harder to prove ownership if serial numbers have been removed/altered. By installing RFID tags in various locations around the vehicle ownership can be proved immediately as the unique signature of the transponder should only be known to the correct owners. Painting over tags is no problem so they can easily be hidden to look like part of the item being protected. Police forces could be informed of the Tag serial numbers when an item goes missing and carry out random checks at ports and other exit points within a country, thus preventing the asset from being spirited away to another location.

Beer kegs are tagged with RFID [31] to automate the supply chain and to track the whereabouts of these valuable items. A hotel or pub cannot now claim they 'did not receive' that keg because the delivery driver logged it off the wagon and into their establishment, thus providing a mechanism for recovering the cost of the item should it go 'missing'. Other returnable items such as special pallets or other transport structures can similarly be tagged to ensure their safe return.

3.2.4 Baggage Handling

For the airline industry, getting passengers to their destinations on time and with their accompanying luggage is a feat that requires identifying and tracking millions of items daily. With use of RFID smart labels airlines now can have reliable, economical baggage identification and tracking solution for positive passenger-to-baggage verification and reconciliation. The Tag-it system [32] can be integrated with existing baggage tags, check-in desk printers, and sorting equipment. Luggage can be automatically scanned in groups, no matter the orientation of the bag or whether it is overlapped with others. Live field trials have proven RFID to be more robust and reliable than the existing barcode system. RFID Smart Labels can be delivered at a volume price, which makes RF bag tags cost-effective as a consumable label.

British Airways have conducted trials of **Tag-it™** (a paper label based RF-ID transponder), in Europe with over 225,000 pieces of luggage having been transferred successfully between airport hubs from Manchester and Munich to London's Heathrow Terminal 1 [33]. The trials clearly demonstrated the effectiveness of the technology in identifying and tracking baggage transported through the sorting systems. The system provided 100% accuracy. BA is openly sharing the trial data with other airlines and standards groups worldwide in an effort to accelerate the adoption of this technology.

3.2.5 Product Authentication, Security

The expansion of worldwide trade, the web marketplace explosion, and growing business-to-business e-commerce only means that criminals have growing opportunities for counterfeiting and fraud.

Combating these problems effectively requires identification technology that is cost-effective to use, yet prohibitively expensive to copy. Smart labels are used in the manufacturing of expensive branded merchandise, where they are embedded directly into products such as clothing and designer goods to provide authentication through the supply chain. Smart labels can also be embedded into items like printer ink cartridges to ensure that only the correct consumable replacements are used in equipment.

RFID could be used to secure cars. Tamper proof and secure, with a unique identification code contained in each transponder ensures that TIRIS automotive immobilisers offer the highest levels of security [34]. The small TIRIS transponder can be attached or embedded into ID badges, Key rings, Vehicles and products. A reader in the ignition system transmits a signal through the air to the transponder that answers back in milliseconds with a unique identification code sent to the reader and then the host system allowing the vehicle to start.

More than 16 million vehicles around the world are now equipped with TIRIS. Typical automotive users include, Bosch, Chrysler, Ford, Hyundai, Mitsubishi, Mobil, Nissan, Sensomatic, Siemens and Toyota .

3.2.6 Supply Chain Management

RFID, combined with telematics, can provide supply chain visibility, boost operational efficiency and give companies the flexibility to react on the fly to changes in demand. RFID technology can connect all phases of the supply chain, from resourcing and manufacturing to inventory and distribution. RFID can create real time information links about business needs to identify and manage raw materials, manufactured goods, products in distribution/transport or products in transit. This makes it easier to manage inventories, route and reroute shipments, positioning products and access real time information about products condition (temperature, pressure, etc.).

Improved safety and security is the other major benefit that RFID can provide. By identifying specific materials with RFID tags, companies will have more accurate, up-to-date information on the location of potentially dangerous products like chemicals or highly flammable materials. RFID can help you be sure not putting materials or substances next to each other that should be miles away from each other. RFID also will allow companies to more accurately verify products moving through customs and help to stop the import and export of illegal goods.

RFID used for Supply Chain Management can make a very interesting potential for telecom companies. A lot of communication and information management will take place. However, according to experts [35], even though an investment in an RFID-system for supply chain management could give solid return on investment the freight industry likely will be one of last sectors in the supply chain to adopt the technology. Many logistics companies such as FedEx or UPS already do a good job of tracking the location of goods with other types of technology. Two other key issues that could affect adoption rates include the cost of RFID tags and readers - although prices of readers and tags have been dropping and will become less of a factor - and ownership of the data gathered by RFID systems,

Transport companies that move high-priced goods, such as computers or other electronics, likely will be among the earliest adopters within the industry. Because RFID is expected to help reduce product shrinkage and theft, tagging expensive items, or the cases in which they're shipped, will bring higher payback.

3.2.6.1 Example – Smart Pallet System

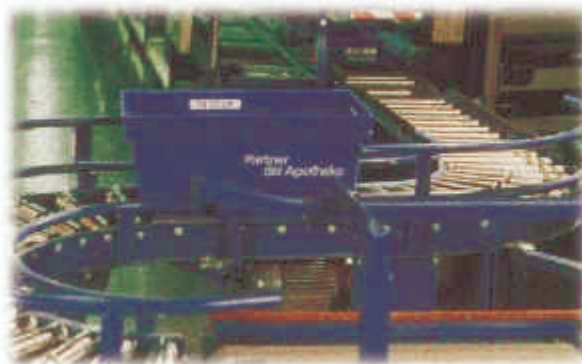
Unilever, the 25th largest company in the world, uses RFID technology as the backbone of a smart pallet system [36] designed to revolutionize how consumer products are moved, handled and tracked in their warehousing facilities. The RFID based system solves the problem of management information connected to the flow of materials. At the heart of the system is a small transponder mounted at the bay doors in the warehouse through which pallets pass. When a pallet reaches the loading bay, another transponder lets the computer know which trailer it has entered. When the trailer is full, the truck scale automatically compares the total weight of its load with the individual pallet weights the computer has in memory, and signals any discrepancy. The RFID system has raised productivity by increasing the number of pallets handled daily and guaranteeing the validity of information about material movement.

3.2.6.2 Example – Warehousing

An early adopter of the technology has been Tesco, the UK supermarket chain [37]. Tesco in January said it was piloting RFID-aware shelves with razor-maker Gillette. Wal-Mart and Proctor & Gamble are also advocates of the technology. The shelves communicate with the company's inventory management system so employees know when they are running out of a particular product, helping reduce losses due to theft or lack of stock.

3.2.6.3 Example – Tote Bin Application - Product Tracking System

Product carriers can be tagged for order picking or for routing purposes to the next workstation. The tags are fixed to the Tote Bins and read by fixed installation readers at the side of the conveyor system, the unique TIRIS codes are sent back to the computer controlling the conveyor system to



allow the routing of the bins [38].

Figure 9: Tot Bin Tracking (Source: www.rf-id.com)

If programmable RF-ID Tags are used then the tag can be updated at each stage of production thus giving the system controller visibility of the production system, whilst also effectively updating the product build/job card in real time.

3.2.7 Transportation

For transportation and fleet management, RFID is an enabler for making more time effective transportation system and giving better customer service. Several places in Europe RFID tags have been placed on buses. Further RFID readers are placed in bus terminals, along the route and in

traffic lights. This make a public transportation system that increases terminal capacities, gives better information to customers and drivers, and that can give priority to public transport vehicles in crossroads/traffic-lights. In following sections, two examples are described briefly.

3.2.7.1 Improving Bus Terminal Management using RFID

In the city of Vejle, Denmark, the main bus terminal had too little capacity to handle all incoming buses and passenger service was at a low. Located in the centre of the city, expanding the terminal area was not a viable option. A new advanced Terminal Management System, using RFID technology, was put into operation in 1999 [39]. The terminal is now able to handle 149 buses operating 13 city routes and 22 regional routes, with a total of approximately 800 arrivals and departures every day. Passengers can watch departure and platform information for all buses within the terminal's new waiting area, at each platform or in the café. Based on such real-time information, passengers can stay in the waiting area or go shopping knowing for certain when the bus will arrive, even if delayed.

The problem of under-dimensioned bus terminals is that a fixed platform for each bus line is too rigid a system to manage and inconvenient for passengers. The solution to this problem is a system, which automatically enables a dynamic allocation of loading and unloading platforms according to available space. Thus, no buses have a fixed platform, which they must use at the terminal. Instead, upon arrival to the terminal the bus drivers are automatically told by the system where to unload and load passengers and where to wait in between if necessary.

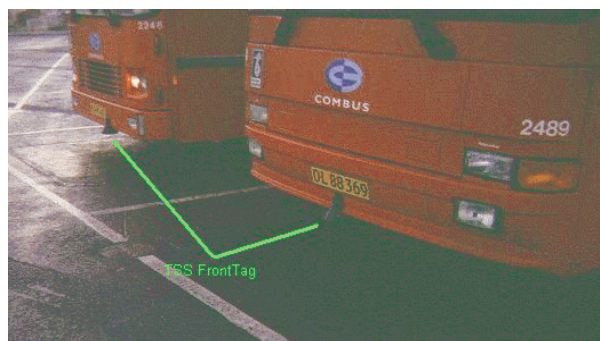


Figure 10: RFID Tags on buses in Vejle (Source: [www. aimglobal.org](http://www.aimglobal.org))

The buses in Vejle have a battery-less Tag fastened to the front bumper. Embedded in the road surface at intervals along the routes leading to and from a terminal, as well as within the terminal, are RF-Readers which power up the Tags and read the unique ID codes stored in the tag memory every time a bus passes. Since the Tag ID codes are only read when a bus is directly above the RF-Reader, this method positions the bus within 1 meter. In-between RF-Reader locations, bus positions are derived from odometer readings related to the latest known position. It allows the system to monitor how buses approach the terminal and adjust for any unexpected delays. In addition to identifying buses based on Tag ID codes, the RF-Reader has a metal detection function, which can verify whether a bus is still parked at a platform or if it has left.

3.2.7.2 Vehicle Access System

In Edinburgh Scotland a RFID based system (TIRIS integrator) including 57 reading points around the town are used to track and monitor the cities public transport system [40]. As a bus approaches a traffic light it passes over an in-ground antenna that triggers the light to change depending on the priority status of the vehicle. The system can trigger green light wave-through for buses and other public transport as well as emergency vehicles such as police, ambulance and fire trucks.

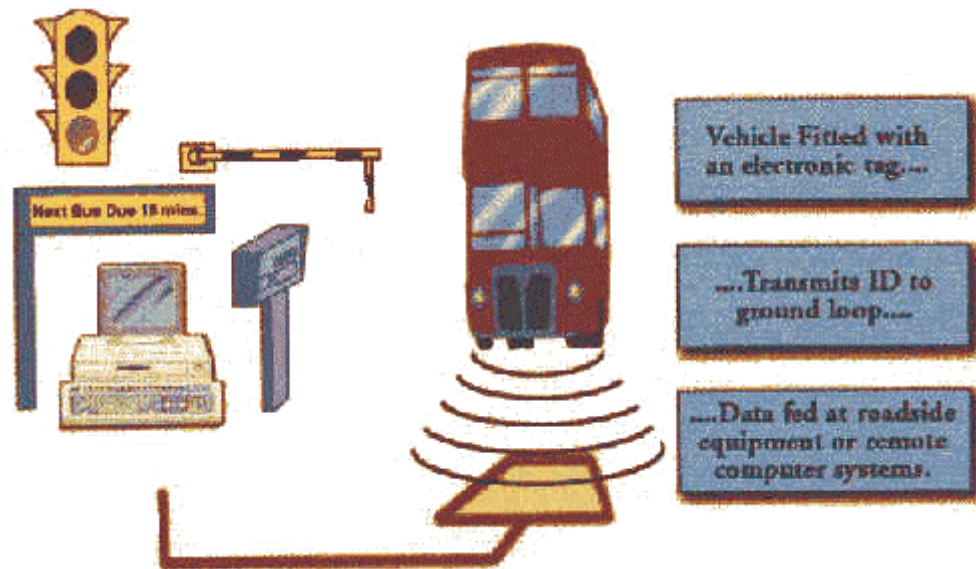


Figure 11: Vehicle Access System (Source: www.rf-id.com)

The TIRIS transponders mounted on 800 vehicles in Edinburgh Scotland are helping to reduce congestion and have increased bus usage so much that the system has already been extended by adding a further 23 additional read points around the city. Variations on this theme are now becoming visible around the world with Brazil tracking its buses into and out of Brasilia by enabling the production of real time arrival and departure information for the cities 400,000 bus passengers.

3.2.7.3 Reduction of fleet size

Associated Foods Stores, a Salt Lake City grocery distributor, slashed the number of tractors in its fleet to 67, from 120, after installing an RFID real-time locating system that uses battery powered RFID tags [35].

3.2.8 Wireless Commerce

RFID are used for making more effective and convenient systems for commerce. Examples of such systems are wireless payments, toll collections (roads) and customer knowledge/information collection used to personalize product offers and gain loyalty. Further RFID is used for making it easier to present accessories for products and other additional information.

3.2.8.1 Prada Epicenter store makes an unusual experiment in retailing

Prada, the Italian clothier, has reinvented the retail environment in one of their stores in New York [41]. Technology plays a big role in the store. Among different technologies, RFID technology is used for several purposes.

Any pair of shoes, handbag, or dress is equipped with an RFID tag. Small handheld readers are located on shelves around the store, where the tags can be scanned. Video monitors are used to show the clothes on the runway, show a collection of photographs and designer sketches, or provide more in-depth information about the colour, cut, fabric, and materials used to create it.

High-tech dressing rooms are equipped with RFID enabled smart closet. The closet reads the RFID tag and displays information about the suit on a liquid crystal screen with a touch-screen overlay. Accessories can be presented, or the customer can see the same item in different colours. The content displayed is all related to the item in the closet. The sales associate can use the screen to up-sell by showing you items that might go well with your suit.

Prada are also trying to use RFID for making service more personalized. This requires the customer present a RFID card to a sales associate, who scans the RFID chip in it. The customer's preferences, earlier buys, etc. can then be presented. The system adds information every time the customer is visiting the store. By this, Prada learn more and more about their customer.

3.2.8.2 ExpressPay from American Express offers convenient and hassle-free alternative to cash

In July 2003 American Express Company announced a pilot expansion in the greater Phoenix area of its latest payment product, ExpressPay. ExpressPay is a fee-free, key fob (key chain attachment) powered by RFID technology that offers a quick, convenient and contactless way to make purchases. ExpressPay is now available at more than 175 merchant locations [42].

ExpressPay is an easy-to-use alternative to cash for making purchases at merchants where speed and convenience are important – such as quick serve restaurants, supermarkets, drug stores, gas stations, and corporate cafeterias. Users simply hold the ExpressPay key fob next to a companion reader at checkout to make purchases. Payment is authorized in seconds and no signature is required. ExpressPay links directly to an existing credit, charge or debit card to fund the purchase.

Since the launch of the ExpressPay pilot, results show that participating merchants have seen customer spending increase by 20% – 30% compared to their cash spending, while customers have seen their checkout time reduced by 30% – 40%.

3.2.8.3 Nokia, MasterCard test wireless payment

Nokia and MasterCard Internationals have teamed to test technology that they hope will someday give mobile phones new wireless credit card capabilities [43]. In a market trial to begin later this month in Irving, Texas, Nokia will distribute phones with snap-on phone covers that have an embedded Radio Frequency ID (RFID) chip. The chip is programmed with reregistered MasterCard payment account information, using the company's "PayPass" payment technology.

The technology being tested by Nokia and MasterCard allows consumers to use their mobile phones to pay for food, tickets, gas, and many other goods electronically without having to pull credit cards out of their wallets and run them through card readers,

3.2.8.4 Retail Initiative - Branders self service checkout counters

At its 'Amnion 98' industrial design exhibition, held on the 30th November 1998, The Faculty of the Built Environment of the University of New South Wales in Australia showed its BRANDERS Point of Sale system based on RFID transponders [44].

The design features an attractive set of checkout aisles for retail outlets, checkout aisles that are targeted at the self-service customer. The aisles restrict the passage of the trolleys or baskets while their contents are scanned, transfer funds from the client's credit/debit card and then allow the passage of the trolley from the aisle. By following up the aisle with an integrated long range EAS system, the retailer is assured that all the goods have been paid for. This design, although a few years ahead of the RFID industry, shows the clear potential and increased client friendliness that can be offered by the next generation of marking systems.

3.2.8.5 Toll collection

Several places in the world system for Electronic Toll Collection (ETC) have been installed along roads. Different technologies are used. ETC help reduce transit times and traffic congestion, by streamlining the toll transaction process.

An example of this is the system in Manila, Philippines[45]. As with ETC roads elsewhere, the system uses windshield-mounted radio frequency identification (RFID) tags and lane-mounted tag readers to automatically register a car when it passes through a toll plaza. Motorists using the wireless technology no longer have to stop, wait or find cash, so traffic flows faster. The hardware is integrated with traffic and business management software.

3.3 Market Aspects

The RFID market is monitored and examined by several consulting and market research companies like ABIresearch, Venture Development Corp. (VDC) or Forester Research. These companies are selling studies and reports for several thousand dollars, but also from their gratuitous white papers it is possible to derive some general insights concerning the market situation.

3.3.1 Overall trends for the total market

ABIresearch estimates the total RFID market in 2002 to be about \$1,2 billion [46]. From the diagram (Figure 12) an annual growth of about 22% can be estimated. Since these total market values are the aggregation of hundreds of application, whereby most of them are already introduced in the market and therefore periodically updated, the influence of upcoming new applications with small volumes in the starting phase cannot be resolved. It seems that ABI research does not expect revolutionary influences from new developments in the next four years.

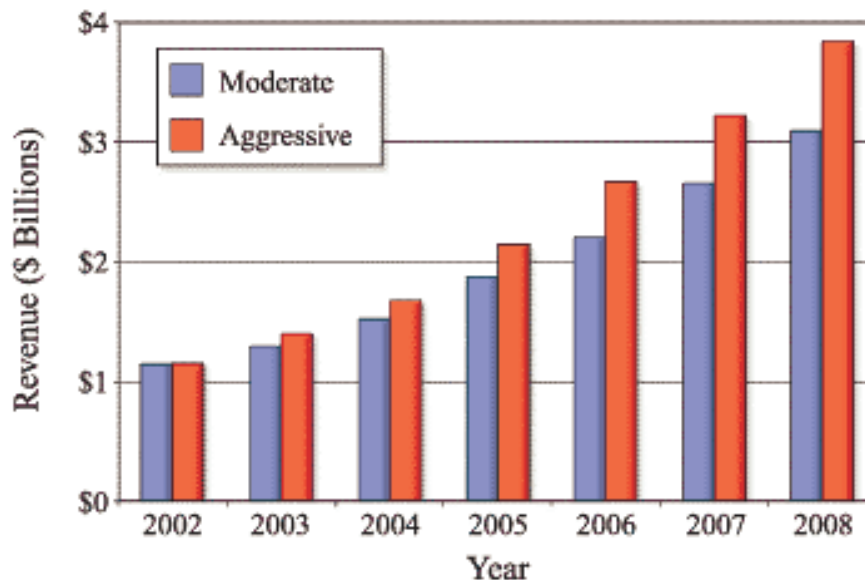


Figure 12: Forecast of the total RFID market value till 2008

The table below shows the global shipment of RFID systems by product category in 2002 acquired by VDC [47]. From this table we can see that the revenue achieved with readers is considerable large. Further more there can be seen that the software slice is only 5-7 % of the total market.

Table 15: Global shipment of RFID systems by product category (source VDC)

<u>Product Category</u>	<u>2002</u>
Transponders	\$463.1
Readers	\$239.8
Software	\$54.9
Service	<u>\$206.7</u>
Total	\$964.5

If you assign one tenth of this software part to the salary of the programmers, this amount corresponds to the work of about 100 software developers. Therefore it can be assumed that complex system software does not yet be assigned to the RFID market. Coincident with