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Identification Technologies: overview, applications and issues

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What is Identification Technology?

Almost every item sold through retailers and supermarkets around the world today has a barcode printed on it. These codes are used extensively throughout distribution chains and are unique to the general type of item being sold. However, in recent years barcodes have begun to show their limitations, and a replacement approach based on radio frequency identification (RFID) technology is gaining momentum.

RFID technology, which uses radio waves for communication, relies on small computer chips and antennas integrated into a paper or plastic label – called a tag – that can be scanned by an electronic reading device. The scan allows automatic collection of data on the chip, which can include information on warranty, where the product was manufactured, or product details such as quantity, size, color, etc.

First developed in the 1960's, RFID technology has proven itself reliable over time, with falling cost structures and further technology refinement allowing it to be used in more common applications today. Consumers are likely to encounter RFID-based systems in their daily lives through applications such as secure access cards for building entry, automated highway toll collection, speedy gasoline purchasing, vehicle anti-theft systems, and transportation systems all over the world.

Unlike barcodes, RFID tags are insensitive to dirt or scratches and can be scanned from a distance – from a few centimeters to 4 meters – all without requiring direct line of sight. RFID technology also allows multiple tags to be scanned simultaneously, even through external packaging. This presents a significant advantage over barcodes in distribution and retail environments, which is where the new generation of RFID technology is making major inroads.

Types of Identification Technologies
Identification technologies are distinguished in two main types: contactless smart cards (proximity range) and RFID's (vicinity range).

Contactless Smart Cards
Often called "RFID's" as well, contactless smart cards differ significantly from other RFID technologies. Contactless smart cards grant people access to services. These chips, which are usually attached to a plastic card of standard credit card size, but could also be build in cell phones or PDA's, combine (high) security with user convenience. Contactless smart cards operate at extremely short ranges, from 'near touch' up to 10 cm. Because this technology is used in high-secure and often dedicated applications, contactless smart cards, such as the Philips MIFARE® family, often carry moderate to strong security features, including mutual authentication of card and reader, advanced encryption schemes (3DES, PKI), password protection and advanced chip design (incl. security sensors to counter tampering). Single cards cost between 1.00 and 20.00 Euro.

RFID
RFID's on the other hand are used to identify and track goods. Usually these chips take the form of a label or tag, which is attached to the product, packaging, pallet or container. These RFID's come in different families, which have different features, operational conditions and typical applications.

RFID's which are Electronic Product Code (EPC)-compliant such as the Philips UCode® carry a unique 96-bits identification number which is stored via a write-once process in the chip's memory and cannot be changed or removed. These EPC-compliant RFID's are typically used in the supply chain management operations of retailers, warehouses and manufacturers.

Other RFID's, like the Philips I.Code®, offer a state-of-the art, low-cost, re-programmable and disposable solution for source tagging, theft protection and data storage on a product or its packaging. These RFID's are typically used in airline luggage tags, parcel services, rental services, libraries, laboratories, pharmacies and hospitals, and are even used in electronic timing solutions for sports such as marathons, triathlon, cross-country skiing and cycling.

Because of their more or less ubiquitous nature, RFID's carry low to moderate security features, including basic encryption schemes and memory write protection. To

improve consumer trust, RFID's used in the retail environment come with a 'kill switch', a command that – once sent to the chip by the reader device – turns the chip off permanently. RFID's are low cost, ranging from a couple of cents to 1.00 euro.

The table below gives an overview of the types, operating conditions, maximum ranges and typical applications of the various RFID and smart card chip families.

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Main RFID-families

(*) CEPT/ETSI proposal to increase to 8 meters

	LF 125 kHz	HF 13,56 MHz	HF 13,56 MHz	UHF 860 MHz	MW 2,45 GHz
Philips name	HiTag®	MIFARE®	I.Code®	U.Code®	U.Code®
Type	Smart Label	Smart Card	Smart Label	Smart Label (EPC)	Smart Label
Range (max)	1.5 mtr (Vicinity)	10 cm (Proximity)	1.5 mtr (Vicinity)	4 (*)/7 mtrs (Vicinity)	1.5/1.8 mtrs (Vicinity)
Encryption	Moderate	Strong 3DES, PKI	No	No	No
Kill command	No	No	Yes / No	Yes / No	Yes / No
Environment (water, metal)	Water ↗ Metal ↗	Water ↗ Metal →	Water ↗ Metal →	Water → Metal ↗	Water ↘ Metal ↗
Typical applications	Animal ID, Electronic keys, Ski ticketing	Public transportation Ticketing Passports Loyalty Programs	SCM, Rental, Airline luggage Parcel services	SCM, Asset Mgt, Container ID Pallet tracking	SCM, Asset Mgt, Container ID Pallet tracking

Contactless Smart Cards

Contactless smart cards can be used in a broad variety of different applications. These range from low cost paper tickets in public transport, enabling increased convenience in each of the 15 to 20 billion ticketing transactions taking place in train and the bus networks around the world, to banking where the Philips MIFARE® interface platform has achieved Visa level 3 security approval. In addition, contactless smart cards provide

solutions for everything from watches that double as access keys to smart identity cards, contactless e-purse solutions and automated road tolling solutions.

Key-application of contactless smart cards: Public Transportation
Already, the public transportation systems in more than 300 cities worldwide, including the London Underground ("Oyster Card"), Trondheim, Beijing, Shanghai, Minneapolis, Sao Paulo, Santiago, Bombay, Kuala Lumpur ("Touch'n Go") and Seoul, use contactless smart card technology in their paper tickets and season cards.

The rapid growth and acceptance of contactless smart cards for public transport applications is not surprising, considering the many benefits to users and service providers alike. The key benefit is the speed with which transactions can be performed as the card only needs to be placed next to the reader to pay for the fare. This makes contactless systems very convenient and attractive to users as well as to service providers, reducing queuing and delays by allowing passengers to get on or off faster. Also, because the card is contactless, the card reader can be in a sealed unit, protecting it from the environment and reducing maintenance costs.

Smart cards can also help reduce the amount of cash needed in the system, allowing fast and accurate revenue collection and effective financial management with audit trails. They can easily be programmed to support different tariffs for season tickets and concessionary fares for specific population groups, helping optimize the ticket issuing process and reducing administration costs. Also, depending on the application and type of card used, parameters such as time, date and journey can be encoded on the chip to secure authorized use.

Nation-wide roll-out: Dutch Public Transportation
In the near future, the ticketing of the entire public transportation system in The Netherlands will be based on the Philips MIFARE® contactless smart card technology. At full implementation the system will have to contend with an estimated 1.5 billion transactions each year. Dutch travelers will use a multi-application smart card with an e-purse, which can be combined with additional products. The cards can be loaded with value via easy-to-use ticketing machines in stations or at shelters. When passengers board trains, buses or trams, they simply place their card in front of an electronic reader, which scans their card to calculate the fare and deducts it from the card's current balance. The system will also ensure that all fares are credited to the appropriate public transport company. When fully operational, it will improve the traveling experience of more than two million people every day.

Poland
The first MIFARE®-based electronic fare-collection system in Poland was launched in the city of Kalisz in 2000, by the Gdansk-based Emtal Sp. z.o.o. Following the installation of extensive card reloading facilities, this system now covers the city's entire public transport system. In October 2001, one of the biggest smart card projects in Eastern Europe was started when Warsaw transport operators introduced the 'Warsaw City Card'. This multi-application smart card encompasses all public transport within the capital including buses, trams and the underground. Then, in early 2002, the system was extended to include some of the suburban railway companies that cater to Warsaw's large commuter population, providing a complete solution that has already proved to be very popular and is providing real and immediate benefits to transport operators and customers alike. In addition to these existing MIFARE® systems, other Polish cities are planning to introduce contactless smart cards in their public transport systems.

One of the reasons behind Poland's transport operators choosing a MIFARE®-based system is that concessionary rights can be changed while the card is in use - avoiding the need to reissue a card if the passengers' status changes. And considering the diversity of passengers which qualify for concessionary fares in Poland, ranging from the elderly and unemployed adults, to schoolchildren and students, traditional methods of ensuring their rights cannot compete with the proven flexibility of MIFARE® smart card systems.

Other applications
In addition to public transport ticketing, MIFARE® smart cards are finding their way into an increasing range of applications, such as a major road tolling project across the whole of Malaysia or Shells' *EasyPay* petrol card scheme in The Netherlands.

At the research facilities of the Philips High Tech Campus in Eindhoven employees use employee badges with the advanced multi-application MIFARE® ProX smart card technology, which enables them to access buildings or rooms at the Campus according to their security clearance profiles and pay anonymously at the Campus' restaurants.

At the Vienna Twintower business center – one of the highest and most futuristic office buildings in Vienna – over a 100 companies employing approximately 7000 people use a badge of standard credit card size with MIFARE® technology. The Vienna Twintower features the most modern infrastructure and equipment solutions available. In addition to providing a single solution for all office keys and canteen

tokens, the Vienna Twintower-card system handles all admission requests, identification needs and payment records, enabling automation whilst providing the highest levels of physical and financial security as well as convenience and administrative advantages. The Vienna Twintower-card is programmed with the requirements of each company, from simple building access, to cashless payment and sophisticated time attendance models - ranging from pure personnel time attendance to logging of time spent in meeting rooms or in certain project areas. One of the highly interesting applications that can be enabled on the Vienna Twintower-card is ideally suited to busy executives. When entering the tower building through one of many rotating-stile barriers, an elevator can be assigned automatically, ensuring rapid and convenient access and travel throughout the building. And the instant a stolen or misplaced card is reported, that card can be shut out of the system and a new card issued.

RFID and the Supply Chain

Major retailers – including Wal-Mart, Target, Metro, and Tesco – and organizations – like the U.S. Food and Drug Administration and the Department of Defense – that manage huge inventories are leading the supply chain transition to RFID technology.

The Wireless Data Research Group predicts that the RFID market for hardware, software and services is expected to increase by a 23 percent compound annual growth rate worldwide from more than $1 billion in 2003 to about $3 billion in 2007. According to analyst firm IDC, RFID spending for the U.S. retail supply chain will grow from $91.5 million in 2003 to nearly $1.3 billion in 2008. This increase is due in large part to the mandates by leading retailers and the U.S. government to incorporate the technology, and also to increasing RFID adoption in many other application areas.

A recent report by AMR Research on the supply chain results achieved by early adopters of RFID technology in the retail and consumer packaged goods arena showed cost savings of 5 percent of sales. This included savings of 1 percent of sales due to reductions in product loss. The retailers also reduced their expenses by 65 percent in the receipt of goods arena and 25 percent in stocking.

RFID tracking of pallets and shipping cases – from the manufacturer, to the warehouse, to the distribution center, to the final destination – is expected to deliver increased efficiency, more timely and accurate inventory management, greater responsiveness to product recalls, and reductions in theft and counterfeit goods entering the retail arena.

Pharmaceutical companies are also planning to use RFID systems to ensure the quality of their goods. Recent headlines about the need for livestock tracking reports related to disease prevention underscore the need for accurate real time information, which RFID can provide.

Benefits for Consumers

In addition to the consumer applications cited earlier, RFID tags are also being considered for item-level identification of goods purchased by consumers once the cost structure is low enough. Many item-level identification benefits can be found in the retail environment following successful implementation within a supply chain. Retailers will be able to pass on the savings to their customers and also provide consumers with greater convenience, value, choice, and protection.

In the supermarket or retail shop, the same technology that scans a truck-full of goods on the loading dock can quickly scan an entire shopping cart without removing the items, thus shortening checkout time. RFID's positive impact on inventory management – making the right products available at the right time and place – means that consumers will find greater on-the-shelf availability of the goods they want. This improvement in logistics management can also help ensure the freshness of time-sensitive grocery items.

RFID tags can store warranty information, certify authentication of high-end goods, and enable easy identification of updated versions of the same product when customers return to a store.

Focus on Technical and Consumer Use Issues

Companies working to implement the hardware, software and services for these new applications of RFID technology have several challenges that are being collectively addressed by the industry. Progress continues in the standards and technology arenas to allow widespread interoperability and deployment.

For consumers, for whom item-level identification is still several years away, there has already been concern expressed regarding the ways in which the information on the tag will be used. Manufacturers have responded with a feature that can disable the tag at checkout, and have increasingly recognized the need for education on the technical capabilities of the technology and privacy implications. This includes communicating the security and privacy safeguards built into the chips to protect against unauthorized

scanning and tampering, as well as explaining how the limits of the technology prevent such impossible scenarios as satellite tracking of an RFID-tagged item.

A first-ever forum at the Massachusetts Institute of Technology in November 2003 brought together representatives from industry, academia, the media, and privacy organizations to discuss the responsible rollout of RFID technology. The subject has continued to be featured at RFID industry events during 2004 as industry associations, retailers and manufacturers seek to work with privacy advocates and local governments to provide education and options for consumers. In 2004, Philips has participated in workshops on RFID technology and privacy organized by the European Commission and the U.S. Federal Trade Commission, testified at a recently held hearing in the U.S. Congress on RFID and privacy and gave presentations to the Article 29 Working Party in Brussels and the German Federal Data Protection Commissioner in Bonn.
Philips is also chairing the working group on responsible implementation and use of RFID technology of the International Chamber of Commerce (ICC).

The intent of these discussions is to ensure consumers are made aware when RFID technology is included in a purchased good so that the consumer can make a decision about whether to accept the benefits of the technology or opt out upon checkout using the "kill switch". Already, EPCGlobal Inc. guidelines for the use of EPC-tags require a warning message and the EPC-symbol to be attached to an RFID-tagged product, so consumers know where the tag is located (usually at the back of the warning label).

Philips' position on the issue of using RFID in consumer products

The prime aim of smart label technology is to offer companies the benefit to control their production and to optimize their flow of goods. The data on the RFID IC's normally contain product information only, but could be combined by the retailer with other data that relate to the actual customer and stored in a customer database.
As a technology provider, Philips provides the option to either use or disable the functionality of the RFID IC outside of the shop environment. Philips' RFID IC's have a feature that enables the retailer to disable the IC once a product has been purchased ('kill switch') as well as other security features like encryption possibilities and read/write protection. It is up to the retailer to make a choice to what extend and how the RFID IC's are part of his customer marketing strategy. If he chooses not to make use of the security features offered by Philips or if he wishes to combine the RFID IC's product information with customer data, it is his responsibility - which in many countries is a legal obligation - to provide the customer with clear information about the way he uses the RFID IC's in his business and the effects this has on the customer's privacy interests and the possible choices to be made by the customer.

Next steps

As a leading technology provider Philips continues to find technological solutions for privacy and security issues with identification technologies. Recently, Philips Research Laboratories in Eindhoven joined the proposal for the 4-year Dutch research program PERFIDE (Privacy Enhanced RFID Environment) of the University of Twente (project chair), Delft University of Technology, the Technical University Eindhoven, the University of Nijmegen and the Dutch Research Institute for Technology TNO (Delft), which project is also supported by the Dutch Data Protection Authority (project and funding approval still pending under the Sentinels IT and Security Research Program: www.sentinels.nl). PERFIDE is set up as fundamental research in privacy protection. The ambition is to develop tools and methodologies as well as their theoretical foundations for using RFID systems, while preserving the consumer's privacy. Philips Research will employ PERFIDE's results to develop technological solutions for consumer privacy protection in RFID systems. The focus will be on the interaction between the tags and the readers and the prevention of tracking of a consumer as well as the prevention of linking the consumer's actions via his tags' IDs.

Consumer privacy can however not be guaranteed by technological solutions alone. Owners of RFID system shall have to comply with existing privacy regulations, which protect the use of the data legitimately collected via the RFID system. Where there are no privacy regulations applicable, general rules of ethical use of RFID systems must be observed. Questions that need to be answered are: do we really need to combine the consumer's identity with the RFID tag or is it okay to use the system anonymously? How long do we keep the data and what will we do with them? How do we offer the consumer information about the tags and how can he exercise his rights? The answers to these questions will probably have a more significant impact on the consumer's privacy than the technology itself.

More information about Philips and RFID can be found at:
www.semiconductors.philips.com/markets/identification/index.html

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