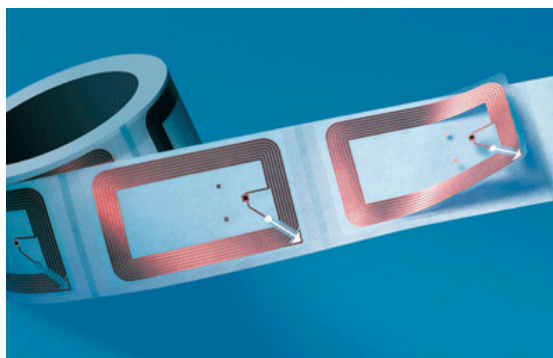


The ABCs of RFID

by Marianne Stanczak

It is used in automobiles that are able to pay tolls without stopping. It is widely used in the packaging and transport industries. It can be in your passport, your luggage, and your library books - maybe it's even in you. Although that last scenario is more the stuff of science fiction novels, radio frequency identification (RFID) is found in many places. But what is it and how does it become so widespread? And is this seeming ubiquity the start of a utopia or something more sinister?



Roll of RFID tags ready for placement on packaging
<http://www.satoeurope.com>
SATO Europe

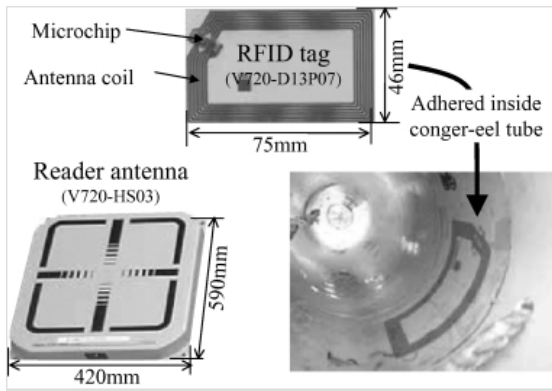
Introduction

Since RFID is often compared to UPC code technology, we will begin here. When a UPC code is scanned, information - usually product name and price - is displayed on a computer or cash register screen. RFID is a wireless technology that uses radio waves to scan or “identify” a product/substance/animal that contains a tag.

RFID technology is normally comprised of three parts: an *antenna*, a *tag* and a *reader*. A tag, also called a transponder, contains a printed circuit board and/or semiconductors. A reader, also called a transceiver, decodes information sent by the transponder. An antenna, generally found on the tag itself, obtains or gives out energy, in this, case radio waves. The data from the tag is sent out through the antenna and read by the reader.

To continue the UPC comparison, an RFID reader reads a tag like a scanner reads a UPC code. Unlike UPC code scanning, RFID tags do not require “direct-line-of-sight,” i.e. they do not require the reader to “see” the tags. They also may contain more product information than a UPC, although this is not always the case. Multiple products, like items on a pallet in a warehouse, can be read simultaneously, whereas UPC is restricted to one coded item at a time. RFID tags can be scanned if the item is dirty, wet or otherwise obstructed since they are read via radio waves and not optical means (again, RFID does not require “direct-line-of-sight”). The reading speed is less than 100 milliseconds even in obstructed conditions or extreme temperatures.¹ Another unique feature of RFID is the so-called “kill” option in which an RFID tagged item is deactivated once a consumer leaves a store.

¹ The AIM Global Network [Association for Automatic Identification and Mobility]
(AIM, Inc., 125 Warrendale-Bayne Road, Warrendale, PA 15086)
<http://www.aimglobal.org/>



The RFID tag (V720-D13P07) and reader antenna (V720-HS03) used in this experiment. The RFID tag was attached on the inner surface of the PVC conger-eel tube.

Uchida, Keiichi et al.
Fisheries Science, Vol. 71, No. 5, pp. 992-1002,
 October 2005

While UPC codes are fairly standard, RFID technology comes in many different shapes, sizes, and capabilities. Subcutaneous implants, like those used to identify missing pets, can be as small as a grain of rice or pencil lead (~10 mm long). Other RFID tags are small enough to be built into casino chips, or as big as credit cards. The plastics tags found on clothing in stores are a familiar example of RFID tags. For especially large applications, such as scanning the contents of railroad cars, an RFID tag may be as large as 120 by 100 by 50 mm.

batteries and must be used at a close range of 3m or less. The antenna, tuned to a particular radio frequency, sends out radio waves. The reader then sends out a radio signal to the tag/antenna, which is activated to transmit the pertinent information. The radio signal contains enough energy to power the tag long enough to send out its information. Most passive RFID tags use Electrically Erasable Programmable Read Only Memory (EEPROM) for small amounts of data.

There are two types of RFID tags - passive and active. Passive RFID tags do not use

RFID Tag Attributes

	Active RFID	Passive RFID
Tag Power Source	Internal to tag	Energy transferred using RF from reader
Tag Battery	Yes	No
Availability of power	Continuous	Only in field of reader
Required signal strength to Tag	Very Low	Very High
Range	Up to 100m	Up to 3-5m, usually less
Multi-tag reading	1000's of tags recognized - up to 100mph	Few hundred within 3m of reader
Data Storage	Up to 128Kb or read/write with sophisticated search and access	128 bytes of read/write

<http://www.rfid-weblog.com>
 RFID Weblog

The more sophisticated active tags use batteries, which make them more expensive; however, the reader can read tags that are ~100m (300 feet) away.² Many use Static Random

² Zebra - Printing Solutions for Business Improvement

Access Memory (SRAM), which means the information in the tag is available as long as it is being powered, for instance with a battery. In summary, an active tag uses an internal power source (battery) while a passive tag uses an external power source (radio waves from the reader).

There are a few frequency ranges in which RFID technology can operate (different applications use different ranges).

LOW FREQUENCY	~ 125 KHz	<0.33 m (1 foot or less)
HIGH FREQUENCY	13.56 MHz	1m (3ft)
ULTRA HIGH FREQUENCY (UHF)*	860 – 960 MHz	up to 100m (10-20ft...300ft)
MICROWAVE FREQUENCY**	2.45 GHz	Various distances

* Television operates at this frequency; some mobile phones use 900 MHz frequency.

** Only some applications, e.g. toll collection

Created in-house by Marianne Stanczak

Drawbacks of RFID technology often depend on what is being scanned/read. Because of the conductivity of metals, objects/products containing them may be hard to read. The tag itself may be comprised of an aluminum or copper foil antenna or silver ink. Other obstacles that may need overcoming are orientation of RFID tags and contents of scanned item:

Contents of packages can dramatically reduce the read rate. Only 25% of the tags on shipping containers containing water filled bottles could be read. Rice filled jars had a higher reading rate (80.6%) Even empty boxes did not have a 100% read rate...The orientation of the tag does make a difference, especially when coupled with a filled package between it and the reader antenna.



RFID tag on prescription drug bottle
<http://www.computerworld.com>
 Computerworld

Tags facing outwards, towards the reader antenna, had the highest likelihood of a successful read. When tags for the boxes of water filled bottles were all facing downward, no tags were read³

The Many Uses of RFID

Technical difficulties aside, RFID technology is used in a variety of industries for inventorying, making for efficient, cost-effective and sometimes surprising results. WalMart is the company that got everything started by making its suppliers use RFID tags. In the non-commercial sector, the Department of Defense (DOD) had a hand in the early stages of RFID technology. Libraries are also a big contender, having used the technology since 1999. The pharmaceutical

(Zebra Technologies Corporation, Corporate & International Headquarters, 333 Corporate Woods Parkway, Vernon Hills, Illinois, 60061-3109, USA)

<http://www.zebra.com/>

³ Clarke, R.H. et al. Radio Frequency Identification (RFID) Performance: The Effect of Tag Orientation and Package Contents, Packaging Technology & Science. Vol.19, pp. 45-54. Jan.-Feb. 2006

company Pfizer uses RFID tags on their products, in one case on “every unit of one popular drug sold in the U.S.”⁴

Most RFID technology is currently used in the packaging industry. The shipping newcomer DHL International GmbH plans to “affix a RFID tag on every package it ships by 2015” to increase efficiency and reduce costs.⁵

But shipping and packaging are not the only uses for RFID. Many state use RFID on their toll roads so motorists who frequent the routes do not have to stop to be charged. Similarly, there is something called an “e-Plate,” which is an electronic RFID-containing license plate. It is an active system in which the plate contains a battery, which in this case can last ten years.



RFID technology in the Supermarket
<http://tech.cybernetnews.com/>
 CyberNet News

Another popular, albeit largely underused, application is for grocery shopping. In the ideal scenario all items in a store, as well as shopping carts and baskets, will contain an RFID tag. A shopper may then leave without waiting in long lines because all items will have been scanned/read simultaneously. And since Visa, Mastercard and American Express “are expected to require more than 4.5 bn RFID cards,”⁶ all items can then simply be put on the consumers’ RFID’d credit card. Building on to the grocery-shopping scenario, once the items are at home, RFID-containing refrigerators will be able to tell you when food is about to expire since, of course, all food items will contain an RFID tag. Along the same line of thinking, there may even be washing machines that, by reading the RFID-tagged clothing items, will automatically know at which settings to wash the clothes.

Safety and security are other main functions of RFID. Medical facilities, such as Brampton Civic Hospital in Ontario, Canada, use RFID in their “child wander-protection” devices to alert cellular phones or other electronic devices when a child leaves a “designated area.”⁷

The US recently began embedding RFID devices into “e-passports,” so that who apply after October 26, 2006 have or will have an e-passport. Safety features include a digital photo and an electronic seal. In addition, a closed passport will be inaccessible to an

⁴ Item level RFID market sizes and growth report: item level tagging is happening faster than many realize. USINGRFID, 17 July 2006, 2pp 2006

⁵ Sullivan, L. Dhl Plans Rfid Tags for Every Package it Ships. Information Week, No. 1043, 13 June 2005, pp. 34

⁶ Savastano, D. RFID and printed electronics: industry analysts forecast the continuing growth of RFID to be USD10bn in a decade. Ink World, Vol. 12, No. 5, May 2006

⁷ RFID and printed electronics: industry analysts forecast the continuing growth of RFID to be USD10bn in a decade. Ink World, Vol. 12, No. 5, May 2006

RFID reader due to metal fibers in the passport's cover that disrupt the radio wave transmission.⁸



E-Passport
<http://techfreep.com/>
 TechFreep Daily Tech News and Free Press

The Department of Homeland Security may use RFID technology as a form of border patrol, scanning immigrants with RFID-embedded visas. Like a monitoring bracelet a person sentenced to house arrest must wear, some RFID devices can be worn by prisoners that allow their movement throughout a penal institution to be monitored.

In the medical field, RFID may be used to avoid malpractice - surgical gauze and sponges may be tagged and subsequently a patient will be scanned before they are closed up to ensure no sponge/gauze is left behind. Blood, drugs, even in-vitro fertilization materials can be tagged in order to avoid costly, even deadly, mix-ups or, in the case of pharmaceuticals, counterfeiting.

In the medical field, RFID may be used to avoid malpractice - surgical

GAO RFID Library RFID Management System



Library RFID Management System
<http://blog.wowgao.com/>
 WowGao Blog

Another large area for the usage of RFID technology is the library system. RFID technology, used since 1999 in libraries, allows for easier inventory control, customer self check out and theft control. As of 2006, about 2% of all U.S. and 8% of worldwide libraries use RFID technology. The Prairie Trails Public Library in Illinois is the “first known totally

⁸ Anderson, S.A. U.S. to issue passports embedded with a chip: new US security passports to be introduced. Wall St.J., Vol. XXIV, No. 134, 10 Aug. 2006

wireless RFID system in a U.S. Library.”⁹

Technological Wonder or Orwellian Nightmare?

Inevitably, with new technology come new concerns. One advantageous use of RFID technology is for public transportation tickets. One fear is that by using the data amassed by ticketing, one could possibly acquire personal “information which may be of interest to the police, divorce lawyers and others.”¹⁰

Another example of illegitimate use of RFID comes from the aptly named website “RFID Virus and Worms.” The site claims that someone purchasing an item at a store could bring the item home and switch RFID tags with a “virus-infected tag.” They would then return the item to the store, where it would be rescanned, thereby theoretically infecting the entire store’s system(s).

Privacy is one of the major issues raised by people against RFID technology. Privacy groups are concerned about government usage of RFID to track individuals’ lives without their knowledge. A group called CASPIAN - Consumers Against Supermarket Privacy Invasion and Numbering¹¹ - is one of several worried that RFID tags will not allow consumers to maintain a sense of anonymity.¹² The claim has been made that “RFID readers have already been experimentally embedded into floor tiles, woven into carpet and floor mats, hidden in doorways, and seamlessly incorporated into retail shelving and counters, making it virtually impossible for a consumer to know when he or she was being ‘scanned.’”¹³

16 And he causeth all, both small and great, rich and poor, free and bond, to receive a mark in their right hand, or in their foreheads:

17 and that no man might buy or sell, save he that had the mark, or the name of the beast, or the number of his name.

18 Here is wisdom. Let him that hath understanding count the number of the beast: for it is the number of a man; and his number is six hundred threescore and six

-Revelations 13:16-18

⁹ Prairie Trails deploys wireless RFID system. *Advanced Technology Libraries*, vol.35, no.5, pp.8-9, May 2006

¹⁰ RFID Viruses and Worms

(Main building VU University Amsterdam, De Boelelaan 1105, The Netherlands)

<http://www.rfidvirus.org/>

¹¹ Watching Them, Watching Us - UK Surveillance Regulation Campaign (including Public CCTV, etc.) (spy.org.uk)

<http://www.spy.org.uk/cgi-bin/spy.pl>

¹² Privacy Right Clearinghouse (Nonprofit Consumer Information and Advocacy Organization)

(3100 - 5th Ave., Suite B, San Diego, CA 92103)

<http://www.privacyrights.org/>

¹³ Privacy Right Clearinghouse (Nonprofit Consumer Information and Advocacy Organization)

(3100 - 5th Ave., Suite B, San Diego, CA 92103)

<http://www.privacyrights.org/>

Perhaps the most alarming to RFID opponents is The Verichip, made by Applied Digital solutions, an RFID chip operating at 125 KHz that is embedded under the skin. Although claimed benefits of the Verichip include access to medical history and protection against identity theft, critics claim that the frequency range is “sufficient for door scanners,”¹⁴ which would be used to keep track of an implanted person’s comings and goings.



Subcutaneous RFID implant
<http://www.engadget.com/>
Engadget



Subcutaneous RFID implant
<http://www.conspiracyplanet.com/>
Conspiracy Planet – The Alternative News &
History Network

Whether you see RFID technology as the Mark of the Beast or a mark of faster, more efficient business practices, it is a rapidly growing field. Perhaps some day long lines at the local supermarket will be a thing of the past, and packaging and other industries will operate at lightning speed.

¹⁴ Watching Them, Watching Us - UK Surveillance Regulation Campaign (including Public CCTV, etc.)
([spy.org.uk](http://www.spy.org.uk))
<http://www.spy.org.uk/cgi-bin/spy.pl>