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The Association of the Automatic Identification and Data Capture Industry

Radio Frequency Identification RFID

A basic primer

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AIM (Automatic Identification Manufacturers), the trade association for the Automatic Identification and Data Collection (AIDC) industry, is *the* source for technically accurate, unbiased, commercial-free, and up-to-date information on all AIDC technologies including:

Bar Code including 2-D Symbologies
Biometrics
Machine Vision
Magnetic Stripe
Optical Character Recognition
Optical Cards
Radio Frequency Identification
Radio Frequency Data Communications
Smart Cards
Touch Memory
Voice Recognition

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Part I : Basics

Introduction

RFID, its application, standardisation, and innovation are constantly changing. Its adoption is still relatively new and hence there are many features of the technology that are not well understood by the general populace. Developments in RFID technology continue to yield larger memory capacities, wider reading ranges, and faster processing. It's highly unlikely that the technology will ultimately replace bar code - even with the inevitable reduction in raw materials coupled with economies of scale, the integrated circuit in an RF tag will never be as cost-effective as a bar code label. However, RFID will continue to grow in its established niches where bar code or other optical technologies aren't effective. If some standards commonality is achieved, whereby RFID equipment from different manufacturers can be used interchangeably, the market will very likely grow exponentially.

This document tries to set out the basic information about RFID in a simple format that can be understood by everyone. AIM's purpose is to provide education on RFID and hence increase the use of the technology. This is part one of a three part series that will also include:

Part II : Application Case Studies

Part III : Getting Started in RFID - A Step approach

A moment's thought about radio broadcasts or mobile telephones and one can readily appreciate the benefits of wireless communication. Extend those benefits to communication of data, to and from portable low cost data carriers, and one is close to appreciating the nature and potential of radio frequency identification (RFID). RFID is an area of automatic identification that has quietly been gaining momentum in recent years and is now being seen as a radical means of enhancing data handling processes, complimentary in many ways to other data capture technologies such bar coding. A range of devices and associated systems are available to satisfy an even broader range of applications. Despite this diversity, the principles upon which they are based are quite straight forward, even though the technology and technicalities concerning the way in which they operate can be quite sophisticated. Just as one need not know the technicalities of a mobile phone or personal computer to use it, it is not necessary to know the technicalities to understand the principles, considerations and potential for using RFID. However, a little technical appreciation can provide advantage in determining system requirements and in talking to consultants and suppliers.

What is RFID?

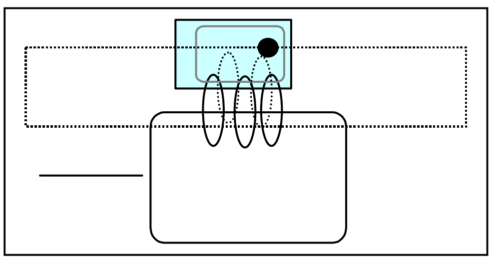
The object of any RFID system is to carry data in suitable transponders, generally known as tags, and to retrieve data, by machine-readable means, at a suitable time and place to satisfy particular application needs. Data within a tag may provide identification for an item in manufacture, goods in transit, a location, the identity of a vehicle, an animal or individual. By including additional data the prospect is provided for supporting applications through item specific information or instructions immediately available on reading the tag. For example, the colour of paint for a car body entering a paint spray area on the production line, the set-up instructions for a flexible manufacturing cell or the manifest to accompany a shipment of goods.

A system requires, in addition to tags, a means of reading or interrogating the tags and some means of communicating the data to a host computer or information management system. A system will also include a facility for entering or programming data into the tags, if this is not undertaken at source by the manufacturer. Quite often an antenna is distinguished as if it were a separate part of an RFID system. While its importance justifies the attention it must be seen as a feature that is present in both readers and tags, essential for the communication between the two.

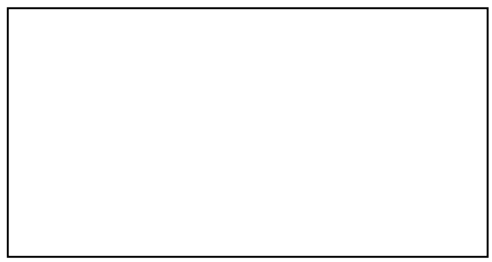
To understand and appreciate the capabilities of RFID systems it is necessary to consider their constituent parts. It is also necessary to consider the data flow requirements that influence the choice of systems and the practicalities of communicating across the air interface. By considering the system components and their function within the data flow chain it is possible to grasp most of the important issues that influence the effective application of RFID. However, it is useful to begin by briefly considering the manner in which wireless communication is achieved, as the techniques involved have an important bearing upon the design of the system components.

Wireless communication and the air interface

Communication of data between tags and a reader is by wireless communication. Two methods distinguish and categorise RFID systems, one based upon close proximity electromagnetic or inductive coupling and one based upon propagating electromagnetic waves. Coupling is via ‘antenna’ structures forming an integral feature in both tags and readers. While the term antenna is generally considered more appropriate for propagating systems it is also loosely applied to inductive systems.



Inductive Coupling



Propagation Coupling

Transmitting data is subject to the vagaries and influences of the media or channels through which the data has to pass, including the air interface. Noise, interference and distortion are the sources of data corruption that arise in practical communication channels that must be guarded against in seeking to achieve error free data recovery. Moreover, the nature of the data communication processes, being asynchronous or unsynchronised in nature, requires attention to the form in which the data is communicated. Structuring the bit stream to accommodate these needs is often referred to as channel encoding and although transparent to the user of an RFID system the coding scheme applied appears in system specifications. Various encoding schemes can be distinguished, each exhibiting different performance features.

To transfer data efficiently via the air interface or space that separates the two communicating components requires the data to be superimposed upon a rhythmically varying (sinusoidal) field or carrier wave. This process of superimposition is referred to as modulation, and various schemes are available for this purposes, each having particular attributes that favour their use. They are essentially based upon changing the value of one of the primary features of an alternating sinusoidal source, its amplitude, frequency or phase in accordance with the data carrying bit stream. On this basis one can distinguish amplitude shift keying (ASK), frequency shift keying (FSK) and phase shift keying (PSK).

In addition to non-contact data transfer, wireless communication can also allow non-line-of-sight communication. However, with very high frequency systems more directionality is evident and can be tailored to needs through appropriate antenna design.

Carrier frequencies

In wired communication systems the physical wiring constraints allow communication links and networks to be effectively isolated from each other. The approach that is generally adopted for radio frequency communication channels is to separate on the basis of frequency allocation.

This requires, and is generally covered by government legislation, with different parts of the electromagnetic spectrum being assigned to different purposes. Allocations may differ depending on the governments concerned, requiring care in considering RFID applications in different countries. Standardisation efforts are seeking to obviate problems in this respect.

Three frequency ranges are generally distinguished for RFID systems, low, intermediate (medium) and high. The following table summarises these three frequency ranges, along with the typical system characteristics and examples of major areas of application.

Table 1. Frequency Bands and Applications

Frequency Band	Characteristics	Typical Applications
Low 100-500 kHz	Short to medium read range Inexpensive low reading speed	Access control Animal identification Inventory control Car immobiliser
Intermediate 10-15 MHz	Short to medium read range potentially inexpensive medium reading speed	Access control Smart cards
High 850-950 MHz 2.4-5.8 GHz	Long read range High reading speed Line of sight required Expensive	Railroad car monitoring Toll collection systems

A degree of uniformity is being sought for carrier frequency usage, through three regulatory areas, Europe and Africa (Region 1), North and South America (Region 2) and Far East and Australasia (Region 3). Each country manages their frequency allocations within the guidelines set out by the three regions. Unfortunately, there has been little or no consistency over time with the allocation of frequency, and so there are very few frequencies that are available on a global basis for the technology. This will change with time, as countries are required to try to achieve some uniformity by the year 2010.

Three carrier frequencies receiving early attention as representative of the low, intermediate and high ranges are 125kHz, 13.56 MHz and 2.45 GHz. However, there are eight frequency bands in use around the world, for RFID applications. The applications using these frequency bands are listed in Table 2.

Not all of the countries in the world have access to all of the frequency bands listed above, as some countries have assigned these bands to other users. Within each country and within each frequency range there are specific regulations that govern the use of the frequency. These regulations may apply to power levels and interference as well as frequency tolerances.

Frequency range	Applications and comments
Less than 135kHz	A wide range of products available to suit a range of applications, including animal tagging, access control and track and traceability. Transponder systems which operate in this band do not need to be licensed in many countries.
1.95 MHz, 3.25MHz, 4.75MHz, and 8.2MHz	Electronic article surveillance (EAS) systems used in retail stores
Approx. 13 MHz, 13.56MHz	EAS systems and ISM (Industrial, Scientific and Medical)
Approx. 27 MHz	ISM applications
430-460 MHz	ISM applications specifically in Region 1
902-916 MHz	ISM applications specifically in Region 2. In the USA this band is well organized with many different types of applications with different levels of priorities. This includes Railcar and Toll road applications. The band has been divided into narrow band sources and wide band (spread spectrum type) sources. In Region 1 the same frequencies are used by the GSM telephone network.
918-926 MHz	RFID in Australia for transmitters with EIRP less than 1 watt
2350 - 2450 MHz	A recognized ISM band in most parts of the world. IEEE 802.11 recognizes this band as acceptable for RF communications and both spread spectrum and narrow band systems are in use.
5400 - 6800 MHz	This band is allocated for future use. The FCC have been requested to provide a spectrum allocation of 75 MHz in the 5.85-5.925 GHz band for Intelligent Transportation Services use. In France the TIS system is based on the proposed European pre-standard (preENV) for vehicle to roadside communications communicating with the roadside via microwave beacons operating at 5.8 GHz.

Data transfer rate and bandwidth

Choice of field or carrier wave frequency is of primary importance in determining data transfer rates. In practical terms the rate of data transfer is influenced primarily by the frequency of the carrier wave or varying field used to carry the data between the tag and its reader. Generally speaking the higher the frequency the higher the data transfer or throughput rates that can be achieved. This is intimately linked to bandwidth or range available within the frequency spectrum for the communication process. The channel bandwidth needs to be at least twice the bit rate required for the application in mind. Where narrow band allocations are involved the limitation on data rate can be an important consideration. It is clearly less of an issue where wide bandwidths are involved. Using the 2.4 - 2.5 GHz spread spectrum band, for example, 2 megabits per second data rates may be achieved, with added noise immunity provided by the spread spectrum modulation approach. Spread spectrum apart, increasing the bandwidth allows an increase noise level and a reduction in signal-to-noise ratio. Since it is generally necessary to ensure a signal is above the noise floor for a given application, bandwidth is an important consideration in this respect.

Range and Power Levels

The range that can be achieved in an RFID system is essentially determined by:

- The power available at the reader/interrogator to communicate with the tag(s)
- The power available within the tag to respond
- The environmental conditions and structures, the former being more significant at higher frequencies including signal to noise ratio

Although the level of available power is the primary determinant of range the manner and efficiency in which that power is deployed also influences the range. The field or wave delivered from an antenna extends into the space surrounding it and its strength diminishes with respect to distance. The antenna design will determine the shape of the field or propagation wave delivered, so that range will also be influenced by the angle subtended between the tag and antenna.

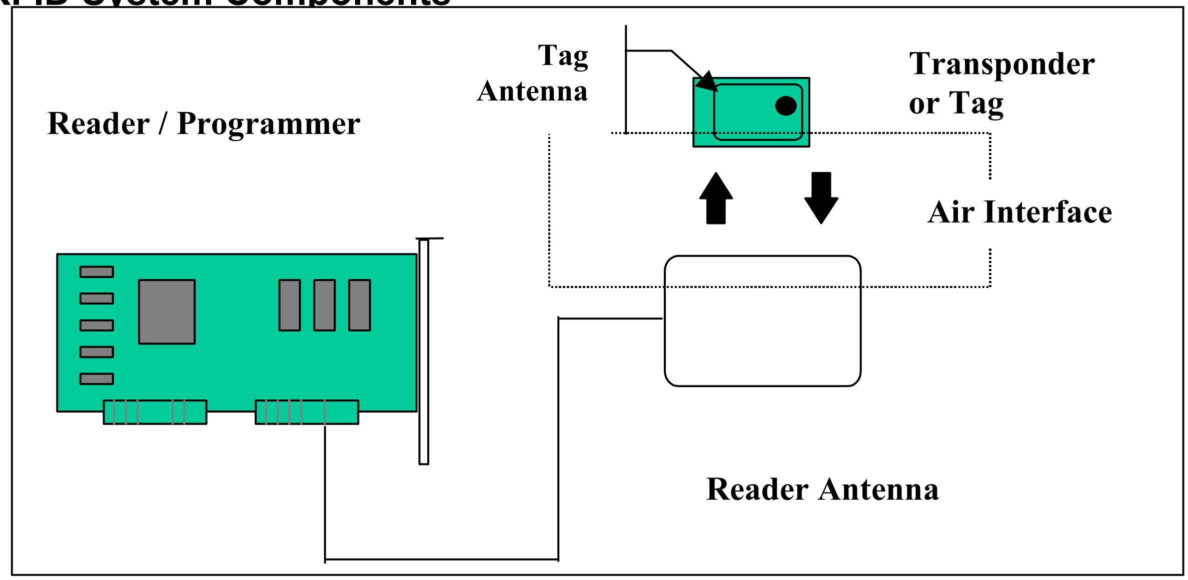
In space free of any obstructions or absorption mechanisms the strength of the field reduces in inverse proportion to the square of the distance. For a wave propagating through a region in which reflections can arise from the ground and from obstacles, the reduction in strength can vary quite considerable, in some cases as an inverse fourth power of the distance. Where different paths arise in this way the phenomenon is known as “multi-path attenuation”. At higher frequencies absorption due to the presence of moisture can further influence range. It is therefore important in many applications to determine how the environment, internal or external, can influence the range of communication. Where a number of reflective metal ‘obstacles’ are to encountered within the application to be considered, and can vary in number from time to time, it may also be necessary to establish the implications of such changes through an appropriate environmental evaluation.

The power within the tag is generally speaking a lot less than from the reader, requiring sensitive detection capability within the reader to handle the return signals. In some systems the reader constitutes a receiver and is separate from the interrogation source or transmitter, particularly if the ‘up-link’ (from transmitter-to-tag) carrier is different from the ‘down-link’ (from tag-to-reader).

Although it is possible to choose power levels to suit different application needs is not possible to exercise complete freedom of choice. Like the restrictions on carrier frequencies there are also legislative constraints on power levels. While 100 - 500mW are values often quoted for RFID systems actual values should be confirmed with the appropriate regulatory authorities, in the countries where the technology is to be applied. The authorities will also be able to indicate the form in which the power is delivered, pulsed or continuous, and the associated allowed values.

Having gained some grasp of the data communication parameters and their associated values it is appropriate to consider, in a little more detail, the components of an RFID system.

RFID System Components



Transponders/Tags

The word transponder, derived from TRANSmitter/resPONDER, reveals the function of the device. The tag responds to a transmitted or communicated request for the data it carries, the mode of communication between the reader and the tag being by wireless means across the space or air interface between the two. The term also suggests the essential components that form an RFID system – tags and a reader or interrogator. Where interrogator is often used as an alternative to that of reader, a difference is sometime drawn on the basis of a reader together with a decoder and interface forming the interrogator.

The basic components of a transponder may be represented as shown below. Generally speaking they are fabricated as low power integrated circuits suitable for interfacing to external coils, or utilising "coil-on-chip" technology, for data transfer and power generation (passive mode).

Basic features of an RFID transponder:

The transponder memory may comprise read-only (ROM), random access (RAM) and non-volatile programmable memory for data storage depending upon the type and sophistication of the device. The ROM-based memory is used to accommodate security data and the transponder operating system instructions which, in conjunction with the processor or processing logic deals with the internal "house-keeping" functions such as response delay timing, data flow control and power supply switching. The RAM-based memory is used to facilitate temporary data storage during transponder interrogation and response.

The non-volatile programmable memory may take various forms, electrically erasable programmable read only memory (EEPROM) being typical. It is used to store the transponder data and needs to be non-volatile to ensure that the data is retained when the device is in its quiescent or power-saving "sleep" state.

Data buffers are further components of memory, used to temporarily hold incoming data following demodulation and outgoing data for modulation and interface with the transponder antenna. The interface circuitry provides the facility to direct and accommodate the interrogation field energy for powering purposes in passive transponders and triggering of the transponder response. Where programming is accommodated facilities must be provided to accept the data m

The transponder antenna is the means by which the device senses the interrogating field and, where appropriate, the programming field and also serves as the means of transmitting the transponder response to interrogation.

A number of features, in addition to carrier frequency, characterise RFID transponders and form the basis of device specifications, including:

- Means by which a transponder is powered
- Data carrying options
- Data read rates
- Programming options
- Physical form
- Costs

Powering tags - For tags to work they require power, even though the levels are invariably very small (micro to milliwatts). Tags are either passive or active, the designation being determined entirely by the manner in which the device derives its power.

Active tags are powered by an internal battery and are typically read/write devices. They usually contain a cell that exhibits a high power-to-weight ratio and are usually capable of operating over a temperature range of -50°C to +70°C. The use of a battery means that a sealed active transponder has a finite lifetime. However, a suitable cell coupled to suitable low power circuitry can ensure functionality for as long as ten or more years, depending upon the operating temperatures, read/write cycles and usage. The trade-off is greater size and greater cost compared with passive tags.

In general terms, active transponders allow greater communication range than can be expected for passive devices, better noise immunity and higher data transmissions rates when used to power a higher frequency response mode.

Passive tags operate without an internal battery source, deriving the power to operate from the field generated by the reader. Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. The trade-off is that they have shorter read ranges than active tags and require a higher-powered reader. Passive tags are also constrained in their capacity to store data and the ability to perform well in electromagnetically noisy environments. Sensitivity and orientation performance may also be constrained by the limitation on available power. Despite these limitations passive transponders offer advantages in terms of cost and longevity. They have an almost indefinite lifetime and are generally lower on price than active transponders.

Data carrying options - Data stored in data carriers invariable require some organisation and additions, such as data identifiers and error detection bits, to satisfy recovery needs. This process is often referred to as source encoding. Standard numbering systems, such as UCC/EAN and associated data defining elements may also be applied to data stored in tags. The amount of data will of course depend on application and require an appropriate tag to meet the need. Basically, tags may be used to carry:

- Identifiers, in which a numeric or alphanumeric string is stored for identification purposes or as an access key to data stored elsewhere in a computer or information management system, or
- Portable data files, in which information can be organised, for communication or as a means of initiating actions without recourse to, or in combination with, data stored elsewhere.

In terms of data capacity tags can be obtained that satisfy needs from single bit to kilobits. The single bit devices are essentially for surveillance purposes. Retail electronic article surveillance (EAS) is the typical application for such devices, being used to activate an alarm when detected in the interrogating field. They may also be used in counting applications.

Devices characterised by data storage capacities up to 128 bits are sufficient to hold a serial or identification number together, possibly, with parity check bits. Such devices may be manufacturer or user programmable. Tags with data storage capacities up to 512 bits, are invariably user programmable, and suitable for accommodating identification and other specific data such as serial numbers, package content, key process instructions or possibly results of earlier interrogation/response transactions.

Tags characterised by data storage capacities of around 64 kilobits may be regarded as carriers for portable data files. With increased capacity the facility can also be provided for organising data into fields or pages that may be selectively interrogated during the reading process.

Data read rate – It has been mentioned already that data transfer rate is essentially linked to carrier frequency. The higher the frequency, generally speaking the higher the transfer rates. It should also be appreciated that reading or transferring the data requires a finite period of time, even if rated in milliseconds, and can be an important consideration in applications where a tag is passing swiftly through an interrogation or read zone.

Data programming options - Depending upon the type of memory a tag contains the data carried may be read-only, write once read many (WORM) or read/write. Read-only tags are invariably low capacity devices programmed at source, usually with an identification number. WORM devices are user programmable devices. Read/write devices are also user-programmable but allowing the user to change data stored in a tag. Portable programmers may be recognised that also allow in-field programming of the tag while attached to the item being identified or accompanied.

Physical Form - RFID tags come in a wide variety of physical forms, shapes sizes and protective housings. Animal tracking tags, inserted beneath the skin, can be as small as a pencil lead in diameter and ten millimetres in length. Tags can be screw-shaped to identify trees or wooden items, or credit-card shaped for use in access applications. The anti-theft hard plastic tags attached to merchandise in stores are also RFID tags, as are heavy-duty 120 by 100 by 50 millimetre rectangular transponders used to track inter-modal containers, or heavy machinery, trucks, and railroad cars for maintenance and tracking applications.

Costs - The cost of tags obviously depends upon the type and quantities that are purchased. For large quantities (tens of thousands) the price can range from less than a few tens of pence for extremely simple tags to tens of pounds for the larger and more sophisticated devices.

Increasing complexity of circuit function, construction and memory capacity will influence cost of both transponders and reader/programmers.

The manner in which the transponder is packaged to form a unit will also have a bearing on cost. Some applications where harsh environments may be expected, such as steel mills, mines, and car body paint shops, will require mechanically robust, chemical and temperature tolerant packaging. Such packaging will undoubtedly represent a significant proportion of the total transponder cost.

Generally, low frequency transponders are cheaper than high frequency devices, passive transponders are usually cheaper than active transponders.

The Reader/Interrogator

The reader/interrogators can differ quite considerably in complexity, depending upon the type of tags being supported and the functions to be fulfilled. However, the overall function is to provide the means of communicating with the tags and facilitating data transfer. Functions performed by the reader may include quite sophisticated signal conditioning, parity error checking and correction. Once the signal from a transponder has been correctly received and decoded, algorithms may be applied to decide whether the signal is a repeat transmission, and may then instruct the transponder to cease transmitting. This is known as the “Command Response Protocol” and is used to circumvent the problem of reading multiple tags in a short space of time. Using interrogators in this way is sometimes referred to as “Hands Down Polling”. An alternative, more secure, but slower tag polling technique is called “Hands Up Polling” which involves the interrogator looking for tags with specific identities, and interrogating them in turn. This is contention management, and a variety of techniques have been developed to improve the process of batch reading. A further approach may use multiple readers, multiplexed into one interrogator, but with attendant increases in costs.

RF Transponder Programmers

Transponder programmers are the means by which data is delivered to write once, read many (WORM) and read/write tags. Programming is generally carried out off-line, at the beginning of a batch production run, for example.

For some systems re-programming may be carried out on-line, particularly if it is being used as an interactive portable data file within a production environment, for example. Data may need to be recorded during each process. Removing the transponder at the end of each process to read the previous process data, and to programme the new data, would naturally increase process time and would detract substantially from the intended flexibility of the application. By combining the functions of a reader/interrogator and a programmer, data may be appended or altered in the transponder as required, without compromising the production line.

The range over which the programming can be achieved is generally less than the read range and in some systems near contact positioning is required. Programmers are also generally designed to handle a single tag at a time. However, developments are now satisfying the need for selective programming of a number of tags present within the range of the programmer.

RFID System Categories

RFID systems may be roughly grouped into four categories:

- EAS (Electronic Article Surveillance) systems
- Portable Data Capture systems
- Networked systems
- Positioning systems

Electronic Article Surveillance systems are typically a one bit system used to sense the presence/absence of an item. The large use for this technology is in retail stores where each item is tagged and a large antenna readers are placed at each exit of the store to detect unauthorised removal of the item (theft).

Portable data capture systems are characterised by the use of portable data terminals with integral RFID readers and are used in applications where a high degree of variability in sourcing required data from tagged items may be exhibited. The hand-held readers/portable data terminals capture data which is then either transmitted directly to a host information management system via a radio frequency data communication (RFDC) link or held for delivery by line-linkage to the host on a batch processing basis.

Networked systems applications can generally be characterised by fixed position readers deployed within a given site and connected directly to a networked information management system. The transponders are positioned on moving or moveable items, or people, depending upon application.

Positioning systems use transponders to facilitate automated location and navigation support for guided vehicles. Readers are positioned on the vehicles and linked to an on-board computer and RFDC link to the host information management system. The transponders are embedded in the floor of the operating environment and programmed with appropriate identification and location data. The reader antenna is usually located beneath the vehicle to allow closer proximity to the embedded transponders.

Areas of Application for RFID

Potential applications for RFID may be identified in virtually every sector of industry, commerce and services where data is to be collected. The attributes of RFID are complimentary to other data capture technologies and thus able to satisfy particular application requirements that cannot be adequately accommodate by alternative technologies. Principal areas of application for RFID that can be currently identified include:

- Transportation and logistics
- Manufacturing and Processing
- Security

A range of miscellaneous applications may also be distinguished, some of which are steadily growing in terms of application numbers. They include:

- Animal tagging
- Waste management
- Time and attendance
- Postal tracking
- Airline baggage reconciliation
- Road toll management

As standards emerge, technology develops still further, and costs reduce considerable growth in terms of application numbers and new areas of application may be expected.

Some of the more prominent specific applications include:

- Electronic article surveillance - clothing retail outlets being typical.
- Protection of valuable equipment against theft, unauthorised removal or asset management.
- Controlled access to vehicles, parking areas and fuel facilities - depot facilities being typical.

- Automated toll collection for roads and bridges - since the 1980s, electronic Road-Pricing (ERP) systems have been used in Hong Kong.
- Controlled access of personnel to secure or hazardous locations.
- Time and attendance - to replace conventional “slot card” time keeping systems.
- Animal husbandry - for identification in support of individualised feeding programmes.
- Automatic identification of tools in numerically controlled machines - to facilitate condition monitoring of tools, for use in managing tool usage and minimising waste due to excessive machine tool wear.
- Identification of product variants and process control in flexible manufacture systems.
- Sport time recording
- Electronic monitoring of offenders at home
- Vehicle anti-theft systems and car immobiliser

A number of factors influence the suitability of RFID for given applications. The application needs must be carefully determined and examined with respect to the attributes that RFID and other data collection technologies can offer. Where RFID is identified as a contender further considerations have to be made in respect of application environment, from an electromagnetic standpoint, standards, and legislation concerning use of frequencies and power levels.

Standardisation

If the unique advantages and flexibility of RFID is the good news, then the proliferation of incompatible RFID standards is the corresponding bad news. All major RFID vendors offer proprietary systems, with the result that various applications and industries have standardized on different vendors’ competing frequencies and protocols. The current state of RFID standards is severe disarray - standards based on incompatible RFID systems exist for rail, truck, air traffic control, and tolling authority usage. The US Intelligent Transportation System and the US Department of Defense (DOD) Total Asset Visibility system are among other special-interest applications.

The lack of open systems interchangeability has severely crippled RFID industry growth as a whole, and the resultant technology price reductions that come with broad-based inter-industry use. However, a number of organizations have been working to address and hopefully bring about some commonality among competing RFID systems, both in the U.S. and in Europe where RFID has made greater market inroads. Meanwhile in the U.S.A., ANSI’s X3T6 group, comprising major RFID manufacturers and users, is currently developing a draft document based systems’ operation at a carrier frequency of 2.45 GHz, which it is seeking to have adopted by ISO. ISO has already adopted international RFID standards for animal tracking, ISO 11784 and 11785.

Just as standardisation enabled the tremendous growth and widespread use of bar code, cooperation among RFID manufacturers will be necessary for promoting the technology developments and refinements that will enable broad-based application growth.

Recommended Reading

Applications of Radio Frequency Identification (RFID), Anthony Sabetti, Texas Instruments Registration and Identification Systems, SCAN-TECH 94.

Radio Frequency Identification Basics for Manufacturing, G. Dan Sutton, President Balogh Corporation, SCAN-TECH 93.

Further Information

This document has been published by AIM International with input and co-operation from all AIM Affiliates. On the next page, you will find the contact information for all of the AIM Affiliates world-wide. You are invited to contact your local affiliate to determine the latest work that is in progress in the RFID arena or any other Automatic Identification and Data Capture Technology.

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