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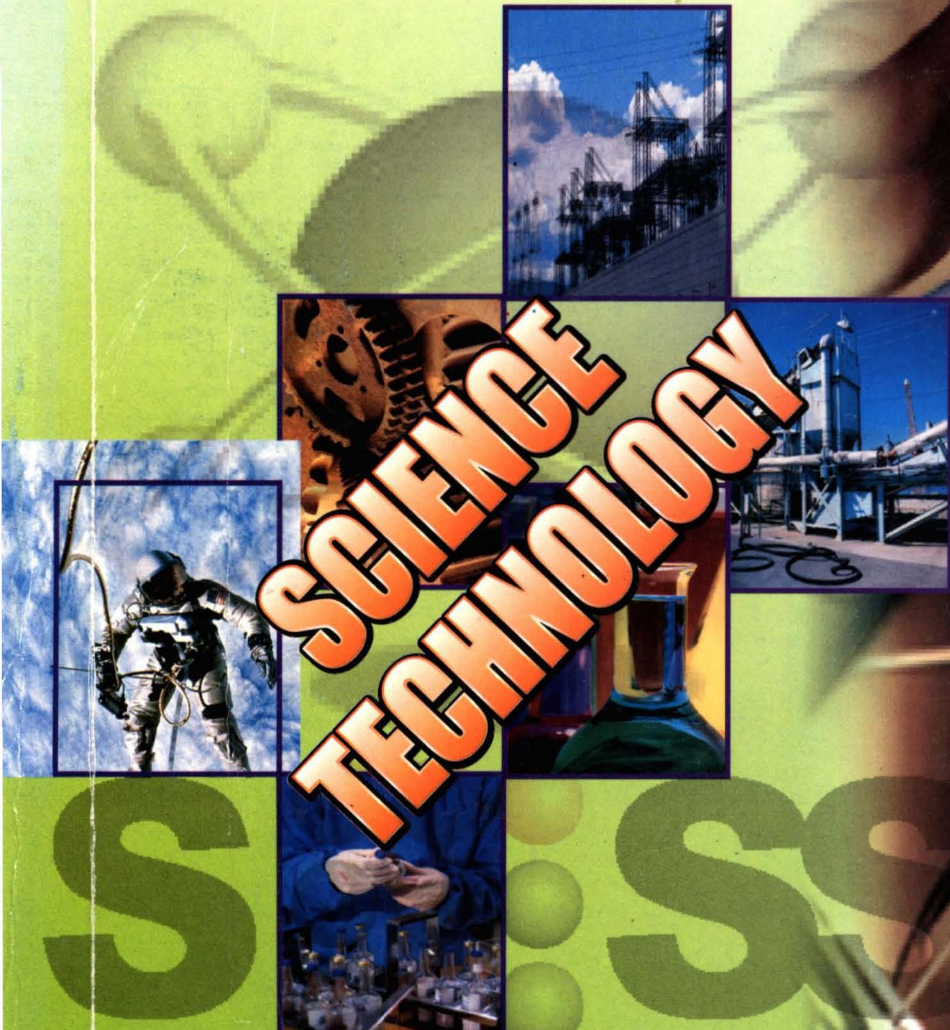
NATIONAL SEMINAR ON SCIENCE TECHNOLOGY & SOCIAL SCIENCES 2006



30-31 May 2006

Swiss Garden Resort & Spa
Kuantan, Pahang

The Implementation of RFID in Aviation Industry: A Preliminary Study on the Technological Aspect

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ABSTRACT

RFID (Radio Frequency Identification) is a new technology that is starting to have significant impact in aerospace/ aviation industry in the world. It has become an increasingly recognized technology with its strong tracking and tracing ability at a much greater level of accuracy, real-time and provides more value at each step in its application. With the aerospace/aviation environments becoming more and more information-intensive, and their information systems are sharing the fundamental information of assuming rather than knowing where and what things are, RFID technology provides the solution for closing the gap between the physical flow of materials and the information flow in the production system. This paper is a preliminary report of an ongoing study and research on the technological aspect of the RFID implementation, focusing in the aviation MRO (Maintenance Repair and Overhaul) industry in Malaysia. This research will also provide a good path for future developments of RFID in any other industry.

Keywords: *RFID Technology, aviation industry, identification system*

Introduction

Many things are hidden in the shrouds of time. The task of tracing history of certain thing or object is challenging, but ultimately rewarding. Our past can open doors to our future. Whether we realize it or not, Radio Frequency Identification (RFID) is an integral part of our life. RFID increases productivity and convenience. RFID is used in hundreds, if not thousands, of application such as preventing theft of automobiles, managing traffic, gaining entrance to secured buildings, controlling access of vehicles to gated communities, corporate campuses and airports, dispensing goods, tracking library books, and the growing opportunity to track a wealth of assets in supply chain management.

Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) is a generic term that is used to describe a system that transmits the identity (in the form of unique serial number) of an object or person wirelessly, using radio waves. It is grouped under the broad category of Automatic Identification (Auto-ID) technology. Auto-ID technologies include codes, optical character readers and some biometric technologies, such as retinal scans. The auto-ID technologies have been used to reduce the amount of time and labour needed to input data manually and to improve data accuracy. Some auto-ID technologies, such as bar-coded systems, often require a person to manually scan a label or tag to capture the data. RFID is designed to enable readers to capture data on tags and transmit it to a computer system – without needing a person to be involved.

RFID dates back to the 1940's when the British Air force used RFID-like technology in World War II to distinguish between enemy and friendly aircraft. The theory of RFID was first explained in 1948 in a conference paper entitled "Communication by Means of Reflected Power" (Stockman 1948), and the first patent for RFID was filed by Charles Walton in 1973 (Takahashi (2004).

How RFID Works

Hardware

A typical RFID tag consists of a microchip attached to a radio antenna mounted on a substrate. The chip can store as much as 2 kilobytes of data. For example, information about a product or shipment – date of manufacture, destination and sell-by date – can be written to a tag. A reader is used to retrieve the data stored on an RFID tag. A typical reader is one or more antennas that emit radio waves and receive signals back from the tag. The reader then passes the information in digital form to a computer system (Figure 1) (RFID Journal).

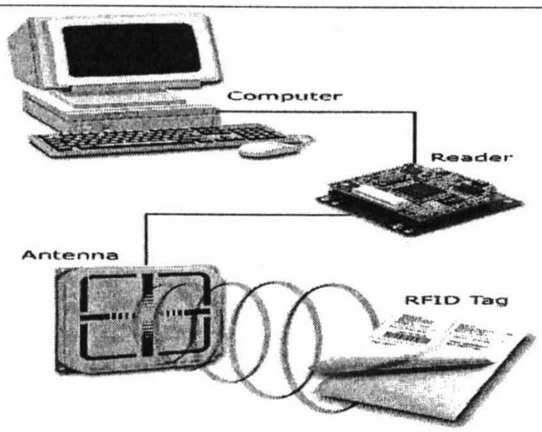

Fig. 1: Typical RFID Component – Computer, Reader, Antenna & RFID Tag
(Source : RFID Journal)

There are some distinct advantages of RFID over the conventional auto-ID system; RFID-installed goods or objects do not need to be positioned precisely relative to the scanner. Most of the time the auto-ID operator has faced some difficulties in making sure that a bar code can be read by the auto-ID scanner. In contrast, RFID devices will work within a few feet (up to 20 feet for high-frequency devices) of the scanner. As the matter of fact, RFID devices are able to store or read data as much as the manufacturing information, as well as the inventory tracking history of a particular product.

There are two broad categories of RFID systems; *Passive* and *Active* systems. *Passive* RFID tags do not have a transmitter; they simply reflect back energy (radio waves) coming from the reader antenna. *Active* tags, on the other hand, have their own transmitter and a power source, usually (but not always) a battery. *Active* tags could draw energy from the sun or other sources. *Active* tags are used on large assets, such as cargo containers, rail cars and large reusable containers, which need to be tracked over long distances (in a distribution yard, for example). They usually operate at 455 MHz, 2.45 GHz, or 5.8 GHz, and they typically have a read range of 60 feet to 300 feet (20 meters to 100 meters) (RFID Journal). There are two types of active tags: *transponders* and *beacons*. *Active transponders* tags are woken up when they receive a signal from a reader. These are used in toll payment collection, checkpoint control and other systems. When a car with an *active transponder* approaches a tollbooth, a reader at the booth sends out a signal that wakes up the transponder on the car windshield. The transponder then broadcasts its unique ID to the reader. Transponders conserve battery life by having the tag broadcast its signal only when it is within range of a reader. *Active Beacons* tags are used in most Real-Time Locating Systems (RTLS), where the precise locations of an asset need to be tracked. In an RTLS, a beacon emits a signal with its unique identifier at pre-set intervals (it could be every three seconds or once a day, depending on how important it is to know the location of an asset at a particular moment in time). The beacon's signal is picked up by at least three reader antennas positioned around the perimeter of the area where assets are being tracked. RTLS are usually used outside, say, in a distribution yard, but automakers use the systems in large manufacturing facilities to track parts bins.

Passive RFID tags have no power source and no transmitter. They are cheaper than active tags and require no maintenance, which is why retailers and manufacturers are looking to use passive tags in their supply chains. They have a much shorter read range than active tags. A passive RFID transponder consists of a microchip attached to an antenna. The transponder can be packaged in many different ways. It can be mounted on a substrate to create a tag, or sandwiched between an adhesive layer and a paper label to create a printable RFID label, or smart label. Transponders can also be embedded in a plastic card, a key fob, the walls of a plastic container, and special packaging to resist heat, cold or harsh cleaning chemicals. The form factor used depends on the application, but packaging the transponder adds significantly to the cost.

Software

Software is the glue that integrates an RFID system. Again, it depends upon the industry context but usually the front end component manages the readers and the antennas and the middleware component routes this information to servers that run the backbone of the database applications. For instance, in a manufacturing context, the enterprise software will need to be made aware of RFID at various levels depending on how far downstream into manufacturing and out into the supply chain RFID is implemented. The RFID Journal categorizes middleware technologies into three levels (Rockwell 2004):

1. software applications which solve connectivity problems and monitoring in specific vertical industries;
2. application managers that connect disparate applications within an enterprise; and
3. device brokers that connect applications to devices like shop-floor machines and RFID readers.

Principles of RFID Technology

The data transfer rate of RFID system, or even in any RF system, is linked to the carrier frequency. The higher the frequency, the higher the transfer rate of the data. It should 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 (Maz Amir Sufian 2005).

The RFID 'tag' is essentially a memory device with a means of revealing and communicating its memory contents, when prompted (scanned) to do so. The memory consists of a plurality of binary (two state) digits, also known as bits, and the communication comprises RF reception and transmission means. The binary data (bits) are formed into binary words comprising typically 8, or 16 or 32 bits that can make up letters and numbers in the same manner as in computing, the Internet and 'texting' on a mobile phone. The 'tag' may comprise an electronic circuit (printed circuit board) with its own power supply – an active device; or be a very low power integrated circuit that is able to gain enough energy from the scanner/reader RF signal to actually power itself for long enough to transmit the contents of its memory – a so called passive device. In its passive embodiment RFID tag transmission power is very low and measured in millionths of a watt i.e. microwatts, µW. Figure 2, shows diagrammatically one of the latter style devices, which may be found on products, particularly consumer durables.

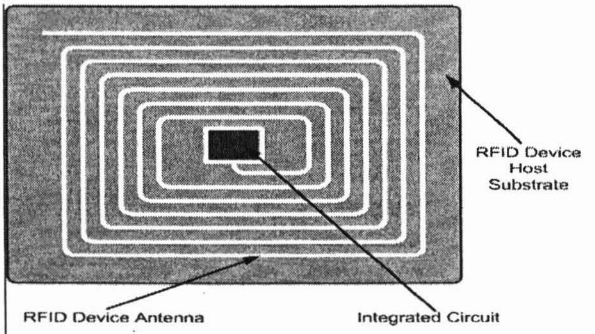

Figure 2.

The data in the RFID tag memory may be pre-loaded determined at time of manufacture) as a Read Only Memory (ROM), or may be dynamically variable (Static Random Access Memory) and take up the status of the last write/ read cycle. The data is always read out serially so that it can be correctly parsed. The information contained in the RFID tag memory is deliberately kept to a minimum, and typically, dependent upon the data format (its syntax, numerical format – decimal, hexadecimal, etc.) requires translating into a human readable form via a host system IEE 2005.

The speed with which the scanner can interrogate the tag and write to it depends upon the RFID technology used, in particular the radio frequency used. Importantly, the necessary proximity between the scanner antenna and the RFID tag for successful operation is dependent upon the radio frequency and whether the tag is active or passive.

There are typically four main frequency bands, used for RFID systems (IEE 2005) as shown in Table 1:

Table 1: Frequency Bands in RFID Systems

Generic Band Name	Frequency Range	Comment (National Frequency Allocations Vary)
Low Frequency (LF)	120 – 135 kHz	Short range inductive applications.
High Frequency (HF)	13.56 MHz	Worldwide common frequency, smart cards and labels.
Ultra High Frequency (UHF)	433 MHz	Active low power tags.
	860 – 960 MHz	Band with major supply chain development activity.
Microwave	2450 MHz	Active tag technology gives range and fast data rates.

The Implementation of RFID in Aviation Industry

Ordinary barcode labels cost less than a cent on average. However, they easily become soiled, dirty, torn, marked over, hidden in frost, and need line-of-sight orientation. Correct orientation requires extra human intervention to make the barcode readable. RFID tags do not have these disadvantages. In addition, unique features such as ability to be written to and long range potentially can spawn a whole new set of applications and radically improve the performance of applications such as inventory management and supply chain management. The possibility of automatically detecting and tracking items promises substantial reductions in costs and time needed for inventory management. In short, applications built around this technology can provide both operational and strategic benefits to adopting organizations (Zaheeruddin Asif & Munir Mandviwalla 2005).

In the aviation maintenance field, the ability to keep track and maintain service histories on aircraft parts is crucial. As the matter of fact, the aviation regulation requires that all aircraft parts that are being approved to be used on aircraft must have full manufacturing and inventory histories. This is to make sure that each part that will be used has the approval and meets the required quality as well.

Airbus and Boeing are turning to RFID to give their supply chains and manufacturing operations a lift. Tagging of parts could reduce counterfeiting and provide other supplier benefits. The Federal Aviation Regulations (FAA) requires that each part and history of an aircraft be tracked individually, which previously involves a lot of paperwork, time and manpower for getting an aircraft certified. The two aircraft manufacturers, that together own the market for large commercial jets, have been holding industry forums around the world to drum up support from customers, parts suppliers and regulatory agencies for the use of RFID. The business case has yet to be proved, but Airbus and Boeing believe RFID could dramatically reduce costs throughout the industry. The two airplane manufacturers expect to achieve internal efficiency in their facilities as they track parts and works in process. Airbus and Boeing should also be able to reduce the cost of receiving goods and including a record of those goods in databases of inventory, while reducing errors and improving inventory accuracy (Violino 2005).

RFID should also enable the airplane manufacturers and their suppliers to reduce inventory across the supply chain, since RFID would provide better visibility of parts from the time they are produced until they are put on a plane. Further, RFID should allow everyone in the supply chain, including the airlines that buy planes, to authenticate parts that have been certified by regulatory authorities and thus reduce the possibility that counterfeit parts are introduced into the supply chain. After the planes go into service, the technology could dramatically improve the way they are repaired. RFID should provide the visibility that enables airlines to trim these inventories while ensuring parts are always where they need to be to keep the planes flying. It should also help repair shops reduce the labour needed to track maintenance cycles (some parts must be reconditioned or discarded after a certain number of miles flown) and repair histories (Mohd Khir Harun 2006). These are some of the problems that are being faced by our country's airline companies, which increase their operational cost every year.

Boeing and Airbus, the world's biggest aircraft manufacturers, have both been working with aviation authorities to allow passive RFID tags for use on planes. Both companies want to use RFID to track and maintain aircraft parts in their supply chain and in operating aircraft.

The Federal Aviation Administration (FAA) has decided to allow *passive* RFID tags to be used on airplanes. "Passive RFID can now be used; 2.45 MHz, 915 MHz and 13.56 MHz passive RFID can all be used as long as they are only interrogated when the plane is not in the air," said Kenneth Porad, Boeing's principal engineer for reliability and maintainability. Prior to the FAA decision, Boeing and Airbus executed studies to determine if on-board RFID tags would interfere with an aircraft's critical systems. As part of that work, Boeing carried out two FAA-approved trials, one involving 13.56 MHz tags and the other using 915 MHz tags, on a working aircraft. After completing the test on a cargo plane operated by FedEx, Boeing concludes that the passive UHF tags are safe for deployment on aircraft. The 90-day trials, on the MD10 FedEx freight airliner involved 13.56 MHz passive tags. The smart labels used in the passive UHF test were placed at few locations, including the flight deck, avionics compartment, cargo compartment and wheel wells (Collin 2005).

These are few possible applications of RFID technology in our country's airline industry, that are significant to be looked into, based on few practical situations that happen almost everyday:

1. Monitoring of 'life-limited' parts that have unique 'identities'. When the part reaches the limit of its useful life, it is destroyed and its unique identity also dies, rendering that part completely un-reusable. Duplicating a dead' part identity is nearly impossible, and this helps prevent the proliferation of fake parts to be installed in life' aircraft;

2. Aircraft mechanic personnel job-by-job tracking, by having the RFID tags on their employee identification badges. This could help drive great improvements in maintenance efficiency, although employee unions might have something to say about this kind of personnel tracking;

3. Mechanics' individual tools could be tagged so that the toolbox would set off an alarm if a tool is not returned. It could, however, be annoying to have a roundup of rollaways announcing that various sockets and wrenches are missing. Perhaps a simple red light, with a message sent to a manager to highlight the missing tool before the shift ends;

4. Calibrated tools would be tagged with current information and they would signal their calibration status prior to use, such as a torque wrench that can measure its own accuracy, thus, cutting calibration costs while also signalling the hangar computer system that it is good to go;

5. With widespread installation of RFID tags on individual parts, a hangar could be wired to read the aircraft's status as it taxies up. The aircraft's maintenance health system would update the hangar computer with any new problems and at the same time report on the actual status of the parts or components that are causing the problem. This would enable the maintainers to get a jump on getting the aircraft back in the air; and

6. Sensors on most aircraft parts could be tied to the RFID tags so that the parts could signal that they have been properly installed or that they are coming apart prematurely.

Conclusion

The purpose of this study is not exactly a race to be the first to take advantage of RFID systems, but it is clearly indicated that the major players in the airplane manufacturing and maintenance industry are looking for an edge today while preparing for the widespread use of the technology tomorrow. Our country's airlines are now looking forward to implement RFID in their companies supply chain and maintenance. They are convinced the technology will help transform their company and the rest of the airline industry significantly. There could be some issues raised by some organizations regarding the implementation of RFID devices especially on the frequency selection and some privacy issues associated with the technology. However, those issues will be solved by future development and extensive used of the RFID technology.

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