RFID: THEORY, IMPLEMENTATION AND CRITICS

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Abstrak

Penemuan *continuous wave* (CW) untuk radio dan teknologi memungkinkan adanya pengembangan terhadap teknologi Radio Frequency Identification (RFID). Perkembangan teknologi ini segera diikuti oleh adanya implementasi teknologi RFID di berbagai bidang usaha. Teknologi RFID meningkatkan efisiensi dan keakuratan dalam pelaksanaan kegiatan sehari-hari terutama di bidang bisnis. Di sisi lain, adanya implementasi teknologi RFID yang baru-baru ini diterapkan kepada hewan dan manusia dengan cara menanamkan sebuah *biochip* ke dalam tubuh hewan dan manusia tersebut telah menuai kritik apakah demi alasan efisiensi dan keakuratan, sebuah teknologi dapat menimbulkan intervensi yang terlalu jauh dan menimbulkan ancaman bagi kehidupan hewan dan manusia.

Kata kunci: teknologi RFID, sejarah RFID, Implantasi chip terhadap manusia.

INTRODUCTION

Imagine when you can experience shopping without having a line to pay what you add to a chart. You can simply put all of the goodies into your chart and walk through the door, while all the bills will be charged automatically and accurately into your bank account. You can imagine also how easy your life will be if you can track your pet wherever it goes; have a fancy car without feeling insecure for someone who can steal it; or maybe just as simple as tracking library books and buying hamburgers. The idea of these illustrations is to show all activities managed and operated automatically, accurately and efficiently.

The examples above become reality when they are supported with the technology named Radio-Frequency Identification (abbreviated as RFID). The abbreviation RFID was granted to Charles Walton in 1983 (see http://en.wikipedia.org/ wiki/Radio-frequency_identification), but the technology itself has been invented many years before and the electromagnetic energy, as the source of RFID, was even here before time.

During 1600, the science seems slowly progressed, but between 1600 and 1800 there was a massive observation about electricity, magnetism, optics, accompanied with the growth of researches in Mathematical base. In 1846, Michael Faraday, an English experimentalist found that both light and waves are being part of the electromagnetic energy. In 1864, James Clerk Maxwell, a Scottish physicist, published the electromagnetic theory.

His theory concludes that magnetic and electric energy travels through transverse waves which propagate equally to the speed of light. In1887 Heinrich Rudolf Hertz confirmed the theory of his predecessor, Maxwell, and was credited as the first man who transmitted and received radio waves. Also, in 1896, Gugliermo Marconi successfully demonstrated the radiotelegraphy through the Atlantic (see Landt, 2001: 3).

In the beginning of 20th century, Ernst F. W. Alexanderson demonstrated the works of continuous wave (CW) radio generation and the transmission of radio. This achievement led to the modern radio communication era when the radio waves could be controlled. Approximately in the year of 1922, the radar was birth. The radar was successfully implemented in the World War II for detecting and locating objects by means of the reflection of radio waves. Later, this radar project was developed by the Manhattan Project at Los Alamos Scientific Laboratory during the WW II. Radar sent out the radio waves, thence the reflection of the radio waves can determine the position and the speed of an object. Later, the combination of these radio disciplines finally generated the RFID technology (see Landt, 2001: 3-4). For further historical information about the development of RFID please refer to following table:

Decade	Event
1940 – 1950	Radar refined and used, major world war II development effort. RFID invented in 1948
1950 – 1960	Early exploration of RFID technology, laboratory experiments.
1960 – 1970	Development of the theory of RFID Start of applications field trials.
1970 – 1980	Explosion of RFID Development. Tests of RFID accelerate. Very early adopter implementations of RFID
1980 – 1990	Commercial applications of RFID enter mainstreams
1990 – 2000	Emergence of standards. RFID widely deployed. RFID becomes a part of everyday life.

Table 1. The Decades of RFID (in Landt, 2001 :7)

Nowadays, the implementation of RFID applies in several areas like business, education, government, public facilities and many more in all over the world.

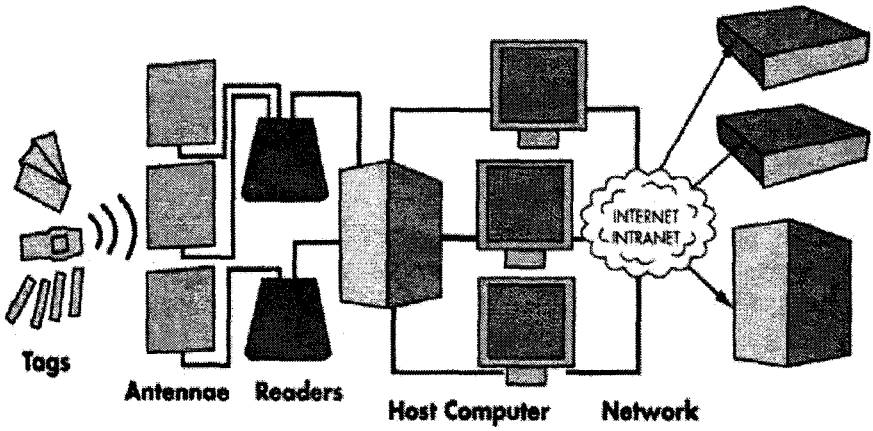
The purpose of this essay does not only to overview the historical development of RFID. It also wants to discuss the theory of RFID, and its implementation in some areas. Including to this implementation is the ethical issue of RFID which is mainly about the implementation of the technology for human body.

HOW DOES RFID WORK?

Nowadays, almost every product we buy from a supermarket has a "product fingerprint" called a barcode. The barcode comes in a form of printable parallel bars which store product's number in a binary code. This barcode can help a manufacturer and a retailer for keeping track their respective inventories. For examples, like how many the quantities have been sold; how much the unit price is; who buys the product and so on. Despite the fact that all the advantages of the barcode, like another technology, the barcode has also disadvantages. To read the data, each barcode must be scanned directly with a barcode reader. Of course, the process of inputting data is automatic, but the reading process itself is still time consuming. Another disadvantage is that the barcode is a read-only technology. It means that the technology cannot send any information out to another device. Because of these advantages, scientists begin to think for a new improvisation from the barcode, that is RFID.

In short, RFID is an automatic identification device which enables us to locate a tagged object with a tiny device so that the object can be automatically detected. Later the RFID technology builds a two way communication between the object and the reader through a radio frequency. A RFID tag often appears as a form of a smart-label, a ticket, a cad, glass beads, an integrated circuit, a wristband or a button (see Maryono, 2005 : 24). These devices can be attached into products so that one can identify and track them. The difference between the barcode and the RFID technology is that the RFID tags have capability to read and write data, while the barcode has only the capability of reading data without sending them to another device. The data stored in RFID can be changed, updated, and even locked (see http://www.dhs.gov/xlibrary/assets/privacy/ privacy_advcom_12-2006_rpt_RFID.pdf).

To support this RFID system, we need at least three kinds of hardware. They are a tag (functioning as a transponder), a reader (functioning as an interrogator), and an antenna (functioning as a coupling device). A reader sends electromagnetic wave to the tag's antenna. In response the tag then supplies the data, which is installed in the form of a product serial number to the reader by means of the electromagnetic wave. Normally after the reader receives the data from the tag, then it forwards the data to a computer host, and finally the computer host transfers data to the network (see Maryono, 2005 : 25). The following illustration describes explanation above.



Picture 1: The Components of RFID Technology (in Gunawan, 2008)

There are also 3 types of RFID tags that commonly used nowadays. They are (See Bonsor, 2007 cf. Gunawan 2008):

1. **Active tags**
   Active tags use an on-board battery which gives power to their circuit. The active tags also use their battery power which enables to broadcast the radio wave so that it could be read by the reader. Because the active tags don't have to rely on the reader as the source of the energy, the tags can be read in a longer distance with a better accuracy, and the tags can provided a more complex data and an exchange of information. But, because the tags use a battery as the energy source, the life of the active tags is short. Moreover, the tags make cost more expensive than other types. Because of its pricey cost, active tags are commonly used for tracking multibillions value objects, which go to around the world. For example, the military supplies.
2. **Passive tags**
   Being different from the active tags, passive tags don't have battery and they fully rely on the reader as the source of their electronic emission energy. The tags can be read up to 20 feet away and they make a production cost lower than the active tags. It means, it can be used for non-expensive merchandises. The passive tags are designed to be disposed along with the merchandise which they are placed.
3. **Semi Active / Semi Passive tags**
   Semi active or semi passive tags are a combination of the active and the passive Tags. These tags have battery, but they still need a reader to supply their battery in order to be able to broadcast. These tags can live for years because the battery is only used when the reader wakes them up. These tags are commonly used since 1980 era for electronic toll collection.

Beside of the types of tags, there is another major concern for the tags, that is, the data storage. There are also three types of data storage: the read-only, the read-write, and the WORM (write once, read many). The Read-only type means the data stored cannot be added to or be overwritten. The read-write type means the data stored can be added to or be overwritten. The WORM means that the tags can have additional data once and after that the tags cannot be overwritten.

Another important part to support the RFID technology is the radio frequency which operates the data transfer between the tags and the reader. Normally the selected frequency depends on the needs, the speed of application, the standardized regulation and many more. For example RFID application for an animal tagging operates in the frequency of 135 KHz (see Gunawan, 2008). The types of the frequency length can be seen below:

Abbreviation	Types	Range	RFID Uses
LF	Low Frequency	30 kHz-300 kHz	125 kHz
HF	High Frequency	3 MHz-30 MHz	13,56 MHz
VHF	Very High requency	30 MHz-300 MHz	Not Used for RFID
UHF	Ultra High Frequency	300 MHz-3 GHz	868 MHz, 915 MHz

Table 2. Types of Frequencies (in Maryono, 2005: 22)

The Implementations of RFID

Nowadays people widely accept the RFID technology in daily life. The RFID can be employed for tracking the very expensive merchandise or the simple process like collecting tolls. In other words people use the RFID in order to support their daily activity. RFID is mostly implemented in the government administration, the public health, the school and library. These implementations are to track down the inventory and to support the use of e-passport. Some implementations in RFID will be discussed in the following points.

A. Business

To improve supply in a chain management, starting in the Fall 2003, Walmart announced to its vendors to include the RFID tags in every goods they sent to the company. Two years after they announced the use of RFID tags, Walmart encouraged their top 100 supplier to use this technology. Surely, this technology is still developing. Yet, the function of technology can improve cost effectiveness and cost efficiency. This fact brings the technology applies into their retail store (See Kelly, 2005,cf. http://en.wikipedia.org/wiki/Radio-frequency_identification).

Car Max uses the RFID to track down cars which have been taken from the lot for a testing drive. FedEx put the RFID chip into a driver's wristband so that the driver can lock and unlock the door automatically without fiddling with the key.

Another story came from Boeing in 2004. Boeing used the RFID technology to reduce maintenance and inventory cost for Boeing 787 the Dreamlines. Since the parts of Boeing are expensive, RFID used for tracking down the parts based on its size, shape and environmental concern. For the first sixth month, Boeing has saved $29,000 just from the labor alone.

B. E-Passport

After the 9/11 tragedy in the United States of America, people are getting more concern about their own safety. This tragedy urges The Department of Homeland Security (abbreviated DHS) to suggest the E-Passport for the air travel safety. The E-passport itself contains some features like a chip identification number, a digital signature, and a holder photograph as a biometric identifier. All of these features will make the holder identity impossible to be forged. The RFID technology in E-Passport is used for a border security and for a more efficient and a more custom procedure at the airport.

One of the major concerns for the RFID used in E-Passport is a potential identity theft. The potential identity theft appears in two forms, they are the skimming and eavesdropping ones. The skimming is the process of reading the tags without the holder's acknowledgement. Meanwhile the eavesdropping is the process of reading the radio frequency emitted from the chip when it is scanned by the reader by an authorized person. The DHS insists that if the proper precautions had been implemented the E-Passport is safely to use. The skimming process can be avoided by inserting the radio shield between the passport cover and the first page. If the passport is closed, the reader will be impossible to read the chip, and if it is open, it can only be read from the 10 cm long. To prevent the chip on the E-passport from eavesdropping, an authorized bureau (for example a department of custom and security in an airport) can cover and enclose thoroughly the scanning area from an unauthorized signal (see http://en.wikipedia.org/wiki/Radio-frequency_identification).

C. Library

It can be predicted that in the future the RFID technology will replace the traditional barcode. The RFID tags can be attached to books, VHS, and DVD. The tags can contain identifying information like book titles and material types. The data in the tag can be read by the RFID reader on the library circulation desk. We cannot only tag books, but also the member cards.

The advantages of using this technology are time efficiency and data accuracy. A librarian doesn't have to open a book or DVD cover in order to scan it. The inventory also can be done within a minute without having to pull out each book from the rack. The tag can only be read by the RFID reader or transmitter within the area of 100 meters so that a librarian will not be worry that the data can be stolen by an unwilling source.

Singapore is the first country which implements the RFID technology for a library. Rockefeller University in New York is the first university which used the technology for the academic library. Meanwhile the Farmington Community Library in Michigan is the first public institution which employs this technology.

D. School and Universities

In Osaka, Japan, the primary school there started with chipping the children clothing, backpack, and student ID. In 2008, St. Charles Sixth Form College in West London, England, implemented the RFID card system for checking in and out at the main gate so that the security personnel there can track the attendance and to avoid unauthorized entrance.

E. Animal and Human Chipping

"I want you....to chip your pets", said the Secretary of the Navy, on September 26th 2006, (as noted in http://www.howstuffworks.com). Secretary of the Navy orders all navies and Marine Corps to implant the RFID chips in the body of their respective pets. This order is issued in order to prevent the navies from neglecting their respective pets if their navy family will be relocated to a new place (See Bonsor, Keener, 2007).

VeriChip, the leading company in human chipping business produces microchip which contains a unique identification number, and this identification is connected to a medical database. This chip can hold emergency contact information and a medical history for a patient. The potential user of the chip is people who have serious medical issues and Alzheimer's disease. The fee itself depends on the implantation and the number of information which want to be inserted into the database. This technology is still developing because not all of the hospitals have a RFID reader. Moreover some medical doctors will not check the patient's chip (See Bonsor & Keener, 2007).

In 2004, Conrad Chase, the owner of nightclubs, offered the chip implantation for the member of his nightclub in Barcelona, Spain and in Rotterdam, The Netherlands. The chip will be used to identify the VIP customers and the chip is used to pay a drink (see http://en.wikipedia.org/wiki/Radio-frequency_identification).

ADVANTAGES AND DISADVANTAGES OF RFID TECHNOLOGY

A. Advantages

It's clearly noted that RFID has many advantages. In business, this technology can affect cost efficiency, or it can supply chain management, and maintain the inventory record accurately as it is happened in the implementation of the technology in a library. Japanese parents will feel safe with the tagged chips into their children stuffs, so they need not to be worried of a children kidnapping.

The security level at the airport is also improved so that it will be difficult more and more to perform a false identity if one uses an E-Passport. Animals can be tracked so that the owners will not feel worried about their respective pets. The clubbers can move freely from a club to club because they don't have to bring their wallet into the night club. The identification and administration process will be processed automatically from the implanted chip in the body of the club member. In short, this technology brings many improvements in a whole aspect of life.

B. Disadvantages

How about our privacy? Would you be ashamed of if people know where you buy your private things and publicized it? Does the implantation in the human body have a side effect? These questions may sounds paranoid for some people, but for some people may not. As far as the side effects of the technology are concerned one can infer that this technology will cause new problems.

It's impossible for an imperfect human to create a perfect technology. But the question is "how far can one tolerate the advantages of the technology?" One of the most concerned disadvantages is the lack of privacy for the user. If the technology is not carefully used, there can be a theft of identity or data by an unauthorized party for example by skimming and eavesdropping. Later on, if there are no specific rules the technology may lead to the human tracking.

Some of the implementation of The RFID on animals and human bodies become controversial because the implanted chip can cause some negative outcomes especially on animal. Some test cases in mice on the mid-1990s proved that the implanted chip could trigger a tumor in animal (see Lewan, 2007). There is no further data about tumor case in the implantation of a chip in the human body. If this happens, however, one can raise a question: "is it worth it to risk our health for the sake of efficiency?" So it is better for the technology itself to be reevaluated thoroughly before it will be implanted in human bodies.

ORWELLIAN: THE CRITICS

George Orwell in his novel *Nineteen eighty-four* (1949) write

> *"The telescreen received and transmitted simultaneously. Any sound that Winston made, above the level of a very low whisper would be picked up by it; moreover, so long as he remained within the field of vision which the metal plaque commanded, he could be seen as well as heard. There was of course no way of knowing whether you were being watched at any given moment"* (see Orwell, in Kelly, 2005).

It might be just a quote from George Orwell. Nevertheless his novel describes a situation, an idea or a social condition which destroy the welfare of a free society (see en.wikipedia.org/wiki/Nineteen_Eighty-Four). All of the citizen are being patrolled by the Thought Police so there's no one who can be independent and rebellious against the Big Brother, the one who have a fully authority to education, government and recreation (see Bonsor, 2007).

We called this technology as "Orwellian" to mention if the technology will intervene too far with our private life. All the descriptions above may just a fiction, but how will it be if this authoritarian condition happens? What will happen if we cannot choose whether the chip should be implemented or not? If we have no more freedom, then what's the difference between human and soda can?

If we talked about Orwellian condition, then we cannot use the effectiveness and efficiency reason as an excuse. Human being is no longer being treated as a dignified person. When an authority can track us down even monitor whatever we do, then where is the freedom? Will the technology dominate human being?

Every person has natural rights equally and these rights belong to any one without exception. As far as that anyone embodies these natural rights is concerned, one can infer that these natural rights are absolute and universal. Thomas Hobbes (1588-1679) and John Locke (1632-1704), who proposes the universality of the natural rights, believe that people have a natural rights because of they are coming from the same species. The theory of the natural rights also help people identifying which administration is legal form and which one is illegal. Some philosophers also suggest that the natural rights include the right for living and the right of having a freedom. John Locke added the right to own property or the property rights into the list. Thomas Jefferson also confirmed if the right of reaching happiness is also included. And last but not least, the French Laws also believe that people have the right of being secure and the right to fight against oppression (Cf, Teichman, 1998:26-27). Scientists and governments should remind about the danger of the Orwellian application of the RFID technology, because it may against the natural law of every human.

CONCLUSION

Despite the fact that the RFID technology has been found for years ago, this technology can be said of being new. On the one hand, one can be sure that the technology brings many improvements to our life, and it can affect efficiency in many aspects of modern business. On the other hand, before one is too eager to implement the technology in all aspects of daily business, one should evaluate thoroughly this intention. We have to think twice if the technology will be implemented in animal's bodies or ours. We can deal with the risk of loosing our freedom if one insists to implement the technology for the sake of efficiency and accuracy of our daily business.

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