

USING RFID AS “MEDICAL ALERT JEWELRY”

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ABSTRACT

Over the past nine years, the reemergence of Radio Frequency Identification (RFID) technology has drawn tremendous attention and has become the new buzz word in various industry segments. It led to exaggerated claims and perceptions by its proponents and opponents alike. After presenting the history, basic components of RFID technology, RFID adoption in various industry segments in the past few years is briefly overviewed. The paper focus on a case study on preventing infant abduction in hospitals. New RFID advances and applications in the medical industry are also discussed.

WHAT IS RFID?

RFID stands for Radio-Frequency Identification. RFID is a force in phenomenon that is opening eyes in almost every sector of the economy. To survive and thrive today, you have to know what inventory you have, how much of it you have and what condition it is in. This is the promise of RFID. The aim is to increase throughput, greater productivity with less labor, increase efficiency, reduce data entry errors and better and faster service throughout the chain of processes involved in a business. It provides 100% visibility and tracking of the inventory throughout the process chain. All these benefits allow businesses to focus on value added functions such as providing better customer service. RFID tags can be attached to or incorporated into a product, person or an animal for the purpose of identification and tracking with the use of radio waves.

An RFID system consists of tags, middleware, readers and antennas. The RFID tags are the most important component of the RFID system and they store the information about the object that is being tracked. The information about the object that is stored in the tags is accessed via the radio signal of the readers. The data transfer between the tag and the reader takes place via electromagnetic waves. In order to get the information from the tag, the reader sends signal to the RFID tag which causes the tag to transmit information to the reader. The reader then reads the signal, converts it into a digital format and then transmits it to the designated application such as an inventory tracking system.

HISTORY OF RFID

RFID technology can be traced back to World War II when there was no way to identify the planes that belonged to the enemy or the country itself. Advances continued through the 1950s and 1960s and research was being done to explain how RF communication systems could be used to identify objects remotely. The last two decades brought more advances. RFID expanded into friendlier uses such as key card systems in hotels, tracking living stock herds and the speed pass toll systems. The technology also made a huge leap into the manufacturing and retail environment with the world's largest retailer, such as Wal-Mart, embracing the new way of gathering information.

THE RFID SYSTEM AND ITS COMPONENTS

Every RFID system has two main components; the first component is the *transponder* or also called electronic identification tag (EID). This is located on the actual object that we are identifying. The

transponder is the actual device carrying the data in the RFID system. The second major part of the RFID system is the *transceiver*. Transceivers are also known as RFID readers or detectors, which may also be a write/read device, meaning it is not only receiving, but it could be capable of sending information to the transponder and rewrite information in it.

Transponders, Tags

Transponders are responsible for storing the information that is needed to be retrieved when we are using the RFID system. The information that is stored in the transponder describes the object that we are working on, tracking. Tags have different attributes. They could be read-write, or write-once, or read-only or active or passive.

Transceiver

Transceiver is the other major part of the RFID system. Transceivers are also called RFID readers. Transceivers are devices that receive radio waves from the RFID transponders (tags) and convert those waves into a digital form that can be transmitted by the middleware software. A transceiver or reader typically contains a high frequency module (also called as transmitter and receiver), a control unit and a coupling element that establishes connection to the transponder.

The transceiver is either physically attached (hard wired or tethered) to the data accumulator such as laptop, or it transmits data to the accumulator wirelessly. A Data Accumulator is anything that can receive and store data. This could be a laptop computer, or electronic scale head or any hand-held storage device, that is capable of communicating with a reader and accept the information from it.

RFID APPLICATION IN DIFFERENT INDUSTRIES

Even though the discovery of radio waves and the technology of radio frequency identification have been around for a while, their application in different industries is gaining momentum very recently. Wal-Mart, Target, and the Department of Defense started using this technology and mandated their suppliers use this technology for supply chain management starting 2003. As the costs of developing RFID tags have decreased during the past few years, use of RFID technology is becoming more attractive option. More businesses are considering the use of this technology not only to streamline their processes but also implement security automation. Examples of RFID applications in medical industry are Instant Patient Data Retrieval and Updating, Tracking Medical Devices and Supplies, Patient Monitoring and Infant Abduction Prevention.

INFANT ABDUCTION IN HOSPITALS

The Problem:

Infant abduction has been one of the increasing concerns in the US hospitals. According to a study by the Boston College School of Nursing, there were estimated 124 infants were abducted from hospitals and birthing facilities, 99 infants were abducted from the home between 1983 and 2008. This statistics is based on reported abduction cases only and there may be many more abduction cases which are not reported to the agencies. It appears that these abduction cases were not associated to a specific geographic region; they are reported in various demographic areas and communities. The study also suggested that the size of the hospitals and rural or urban region did not appear to be a major factor. Additionally there were 33 infants were abducted from other non-hospital places such as malls, offices, and parking lots according to this study.

Statistical data about infant abduction cases below (1983-2008) suggests that it is a growing concern in hospitals and non-hospitals facilities.

Abductions of Infants from 1983-2008: 256, Still Missing: 12

	1983-2008	Case Status
Healthcare Facility	124	Located – 118 Still Missing – 6
Mothers’ room	71 (57%)	
Nurseries	17 (14%)	
Pediatric Units	17 (14%)	
Within Premises (In the healthcare facility grounds)	19 (15%)	
With violence to mothers	9 (7%)	
Homes	99	Located -95 Still Missing – 4
With violence to mothers	29 (29%)	
Other Places	33	Located – 31 Still Missing – 2
With violence to mothers	8 (24%)	

RFID APPLICATION IN PREVENTION OF INFANT ABDUCTION

One of the popular RFID applications being deployed and used in the medical industry, especially in the Labor and Delivery and Neonatal ICU for infant protection and their security from any possible abductions or kidnaps. Here we focus on one product of HUGS & KISSES.

Product Vendor

The Hugs & Kisses products are developed by a software maker named Stanley Healthcare Solutions. They are one of the major solution providers of safety, security and supply chain management in healthcare industry. Their solutions have been deployed in many healthcare institutions globally. Stanley’s application suites for patient security have been providing individual protection to patients in multiple departments in healthcare, from newborns in obstetrics to adults in the emergency department.

Product Description (Hugs & Kisses Infant Protection System)

The Hugs & Kisses infant protection system is state of the art system based on RFID technology. RFID is an industry standard to identify and track any objects with implanted RFID tags using radio waves. Additionally, the product also uses another technology called “Cut-Band” technology, which we will talk about in later portion of this section.

System Components

Hugs Tags: Hugs tags are the core system components which are being attached securely on infants’ wrists. These radio transmitter enabled Hugs tags also incorporate an anti-tamper mechanism which controls any possible tag tempering like breaking or cutting the strap. The tags also have ability to automatically enroll in the system software. As soon as the tags are enrolled within the system and secure on infants’ wrist, it emits radio transmitter signals every 10 seconds which indicates the tag is

present in a secure/protected zone defined by the hospital unit (BabySense Feature). The Hugs tags are also capable of triggering an alert in the scenarios where the ends of bands are not properly tied or connected, or it's been tempered via cut-band technology. The triggers are being monitored at the receiving computer system at multiple nursing units.



Hugs & Kisses receiver

In this exemplified scenario we can demonstrate exactly how the Hugs tag behaves in details. Let's assume that a Labor and Delivery nurse holding an infant passes through an exit which is being protected and monitored by the system, the controller PCs would show the tag ID and exact exit location of the tag. The system is also capable of showing the images of the person who is carrying the infant if the TV monitoring system installed.

Closed-Circuit TV (CCTV):

Optionally the Hugs system is capable of integrating with CCTV which enables monitoring the controlled and protected zone via CCTV produced images at security centers. The monitoring system feed videos and images from the CCTV camera which can be recorded on DVR. With the integrated CCTV camera system, the digital videos and images are being transferred to the Hugs system over the Ethernet connection. When integrated with Hugs system, the CCTV streams the videos on one of the sections on monitor via the application suite in case of triggered events.

The Kisses Component:

The Kisses component is an integral part of the Hugs infant protection system. It provides automated mother/infant matching notification. When mothers are admitted to deliver babies, they are given a Kisses tag. This Kisses tag is associated in the system with the infant's Hugs tag after the birth. These Hugs & Kisses tags are associated throughout the hospital stay on baby's and mother's wrists.

Hugs & Kisses Wristband

Once information about tag Ids of mother and baby in the system, the tags can associate together automatically indicating correct match. In case of mother & baby mismatch, the Kisses tag automatically generates audible alert to notify the staff. The Hugs & Kisses tag reconfirms their association in the situation of mother and infant come in certain proximity after separated for medical examinations in the ward. The Kisses tags have capabilities to support twins, triplets and multiple births.

Local Area Receivers (LARs):

Local Area Receivers aka LARs are developed on a proprietary networking technology called LonWorks, developed by Echelon Corporation. LonWorks network operates on a communication protocol ISO/IEC 14908-1 in a controlled environment. This protocol has been recognized by certain industries as well regulatory bodies such as ANSI, IEEE, CEN and EN. LonWorks supports multiple mediums including power line, twisted pair, radio frequency (RF), and infrared (IR), coaxial cable and fiber optics. Communication protocols, dedicated microprocessors, transceivers and network database are components of the LonWorks platform.

In Hugs system environment, the LARs are installed at a regular distance within the protected or monitored region. These LARs receive RF signals from the Hugs tags and transfer the information to the computer system with time stamp and other information via LonWorks platform. LARs are usually installed in ceilings and other invisible areas of the hospitals. Hugs system continuously monitors the status of LAR devices and produces alerts.

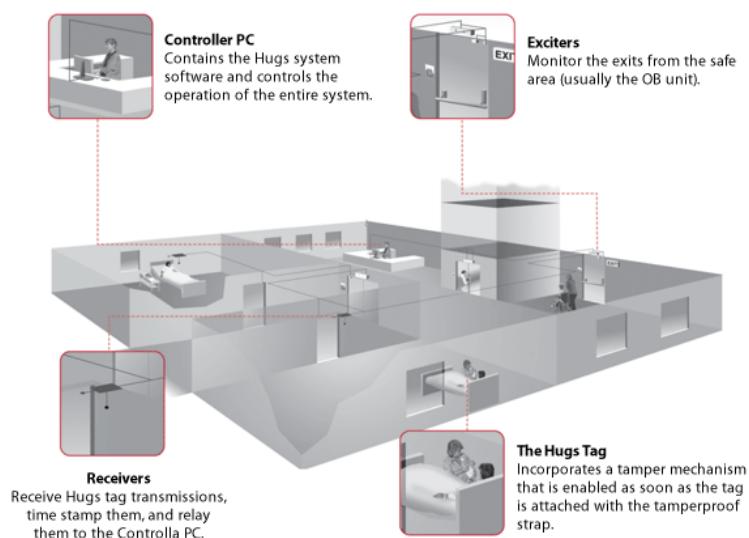
Exciters:

Exciter is another core component of the Hugs system. They are installed and mounted on the exit doors and elevators of the OB and NICU units and connected with doors and elevators via magnetic locks. Exciter emits low frequency radio signals when it detects Hugs tags and passes the information to the controller system via LARs. When an infant with Hugs tag exits via monitored doors or elevators without authorization it sends alerts to the controller system via LARs. The system is capable of locking the exits via magnetic locks which are connected to the doors in the scenario of unauthorized infant removal.

Controller System:

Controller system comprises of a relation database system which enables easy accessibility and modification. The database stores information including alarms and responses, unauthorized events, tag association, etc. with time stamps. The database records can be automatically archived, backed-up, sorted, viewed or printed. The controller server is connected with the network of LARs and exciters via LonWorks peer-to-peer platform. The graphical representation of the floor plan displays defined exits for certain region of the protected area which can be continuously monitored by security or clinical staff. The system is password protected and access/permissions configurable for certain level of task performance. The system generates pager messages in case of alarms when the staff is away from the controller PC.

Following is a diagram showing how the system can be implemented using different components of the Hugs & Kisses System.



THE FUTURE OF MEDICAL RFID

It is difficult to identify the precise future of RFID technology in the medical field. The potential applications are as numerous as they are variable. RFID technology has become very useful in other industries to reduce search time and increase the rate of information exchange. These benefits can improve the face of health care by automating alert systems and give overworked medical staff an alert system, hopefully reducing medical errors and accidents. RFID research in the medical industry is in response to the need to decrease potential errors and increase the rate of information transfer and its availability.

Despite recent advancements in RFID technology and reduced costs of manufacturing RFID transponders, adoption is taking place at a slow pace. Major reasons for the slow adoption seems to be due to the implementation complexity and costs; and lack of standardization.

REFERENCES

- [1] Ann Wolbert Burgess and Kenneth V. Lanning, An Analysis of Infant Abductions. Retrieved from http://www.missingkids.com/en_US/publications/NC66.pdf, November 2009
- [2] Anshel, M., Levitan, S., Reducing Medical Errors Using Secure RFID Technology. *The SIGCSE Bulletin*, 2007, 39 (2), 157-159
- [3] Bhattacharya, M., Mullen, T., Chu, C-H., Chu, and Hayya, J. (November 2009). *An Exploratory Study of RFID Adoption in Retail Sector*. Retrieved from http://tmullen.ist.psu.edu/pubs/DSI_2009.pdf
- [4] Coursey, D. (2004). Medical RFID Tagging Could Save Lives. Retrieved from <http://www.eweek.com>
- [5] Gulf Shipper. (2008). *Delays and high costs hamper RFID adoption*. Retrieved on November 19, 2009 from accessmylibrary: http://www.accessmylibrary.com/coms2/summary_0286-35348826_ITM.
- [6] Healthcare RFID Solutions. (2007). Retrieved from <http://www.pdcorp.com/en-us/index.html>
- [7] Hugs Infant Protection System, System Overview, XMark Inc. Retrieved from <http://www.xmark.com/files/mk50005.pdf> (2009)
- [8] John B. Rabun, Jr., ACSW(^{9th} Edition, 2009) For Healthcare Professionals: Guidelines on Prevention of and Response to Infant Abductions Retrieved from http://www.missingkids.com/en_US/publications/NC05.pdf
- [9] Just the Facts, Hospital Safety and Security Infant Abduction National Center for Missing and Exploited Children. For Healthcare Professionals: Guidelines on Prevention of and Response to Infant Abductions, 5th Edition (2009): Retrieved from <http://www.missingkids.com>
- [10] K. Michael and L. McCathie. (2005) *The Pros and Cons of RFID in Supply Chain Management*. Retrieved from <http://portal.acm.org/citation.cfm?id=1084277>
- [11] O'Connor, M.C. (2009). U.K. Startup Sees Pregnant Opportunity. *RFID Journal*, 5048[1]
- [12] Shou-Yan-Chou and Yulia Ekawati (2007) *Cost reduction of public transportation systems with information visibility enabled by RFID technology*. Retrieved on November 15, 2009 from www.springerlink.com/index/h31u0g1700715204.pdf
- [13] Swedberg, C. (2008). U.S. FDA Seeks Research for Medical Device Tracking System. *RFID Journal*, 4043[1]
- [14] Swedberg, C. (2009). Wisconsin Blood-Tracking Study Moves to Phase 2. *RFID Journal*, 5356[1]