An Overview of Building a Smart Hospital Using RFID Technologies

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ABSTRACT: ***Radio frequency identification (RFID) technologies are rapidly evolving, and healthcare is expected to be one of the fastest-growing sectors. This paper describes how this emerging technology can be used to build a smart hospital after briefly introducing the RFID field's common terminology and current standards. RFID can assist optimize business operations in healthcare and enhance patient safety when used in conjunction with mobile devices in eHealth applications. The second part of this article explains how to use the RFIDLocator, an asset tracking application, to improve the quality of hospital services. The RFIDLocator was created to meet the high demands for scalability and dependability that such an application demands. Its distributed software architecture is described in detail. The necessary procedures for its setup to the concrete case of the hospital are presented in a brief cookbook. This paper concludes with some critical remarks about RFID technology, the important questions it raises, and the barriers it must overcome in order to be fully integrated in eHealth applications.***

KEYWORDS: ***E-Health, Healthcare, RFID, Smart Hospital, Workflow Optimization.***

1. INTRODUCTION

An disturbing figure from an American healthcare group [Hea] states that in each of the years 2000, 2001, and 2002, an average of 195'000 individuals died in hospitals in the United States as a consequence of possibly avoidable in-hospital medical mistakes [Hos04]. [Lin00] declares “The issue in health care isn't terrible individuals–decent it's people working in poor environments,” she says. systems that must be made more secure.” The purpose of this article is to demonstrate how radio frequency identification systems work[1]. (RFID) can help to create a smart hospital by streamlining business operations and lowering costs. Errors are being reduced, and patient safety is increasing. This section begins with a brief overview of RFID technology, as well as definitions of some of its key concepts and standards. Then there's a quick rundown of the settings and equipment. It includes everything you'll need to "RFID-enable" an existing hospital. The second part discusses several intriguing healthcare applications that may benefit from the technology. RFID. This section also shows that many pilot projects have previously been completed successfully. putting this new technology to the test Section 3 introduces the RFID lorator application and demonstrates how it may be customized[2].

A realistic tracking example use case at a hospital is shown. The conclusion highlights the paper's major accomplishments and offers a few recommendations. outstanding issues that must be resolved before RFID can be widely used by the healthcare industry community. RFID (Radio Frequency Identification) is a technique for remotely storing and retrieving data through RFID tags or transponders. An RFID tag is a tiny item that may be affixed to or integrated into a product, such as an adhesive sticker. An antenna is linked to an electronic chip in RFID tags[3]. These chips convert the energy of radio-frequency inquiries from an RFID reader or transceiver into information and transmit it back to the reader or transceiver. Finally, the reader is piloted and the data it transmits is processed by a computer running a particular RFID application or middleware. RFID has many advantages: 1. it can scan tags while they are moving; and [4].

Since radio waves can travel through most solid things, the tags do not need to be in direct line of sight of the RFID reader. It's a good start to have labeled or tagged items that can be identified in a universal and flexible way. Building a network out of these things, such that information about them can be readily retrieved using a unique number, would open up a lot more fascinating use cases[5]. An open standard architecture has been developed to realize the goal of a seamless global network of physical objects: the EPC Network (also known as "The Internet of Things"). The Electronic Product Code (EPC) is a unique identifier that allows for product tracking throughout its life cycle. In the so-called EPC Network, the EPC is the primary asset identification. It essentially includes information about the tagged object's maker; 2. the product class or type of the tagged object; and 3. the unique item itself. To be utilized on wide networks and to be readily modified and shared by software programs, EPCs are often encoded as Uniform Resource Identifiers (URIs). The Physical Markup Language (PML) is a standardized generic markup language for modeling information exchange and encapsulating data collected by RFID readers[5].

1.1 Use Cases in a Smart Hospital:

- *Identification of the Patient:* Many doctors are worried about the rising number of patients who are misidentified prior to, during, or after medical treatment. Indeed, a mistake in patient identification may result in the wrong medicine being given to the patient, as well as the need for an intrusive treatment. Other patient identification mistakes may result in erroneous lab work and results being reported for the incorrect individual, leading to misdiagnoses and severe prescription errors [Sir03]. Several RFID-based patient identification and tracking pilot projects have been established in the past two years in order to reduce clinical mistakes, enhance patient care and security, as well as increase administration and efficiency[6]. For example, the Jacobi Medical Center in New York [Wes05], the Birmingham Heartlands Hospital in Birmingham [Bir05], and the German Saarbrucken Clinic Winterberg [Bes05]. As stated in Subsection 1.2, all patients admitted to the hospital are given an RFID-based wristband that looks like a watch and contains a passive RFID chip3. In order to expedite treatment, this chip contains a unique patient ID number as well as some important medical information such as the patient's blood type. Further medical data is not kept on the devices, but rather in a secure database that connects the unique patient's ID with its data, to protect patient privacy and prevent medical information being inappropriately released[7].
- *Blood Flow Monitoring:* Mis-transfusion mistakes (i.e., blood transfusion of the wrong kind or blood given to the wrong patient) are unacceptably common and severe, according to a recent study [Dzi03]. "In the transfusion setting, misidentification is the most frequent cause of transfusion mistakes that end in death," according to [All02]. Mis-transfusions are most often caused by a mistake made during the bedside check immediately before to transfusion, according to [Sun05][8]. Such mistakes are more likely to occur among surgical patients, according to studies [Saz90]. Currently, bedside checks are performed by humans using eye-readable information, and this job is especially challenging in operating rooms. Indeed, blood is often donated in times of great urgency and preoccupation. During the transfusion, patients are unconscious and unable to speak their names, and caregivers in operating rooms may not be as familiar with the patient as nurses on non-surgical floors. To solve the problem of the bedside transfusion check, new technologies should be used. Bar code technology and RFID are two machine-readable technologies that may be used to automate these inspections[1].
- Barcodes are inappropriate for bedside inspections because they need line-of-sight to scan a flat surface containing the code with a portable laser. This limitation poses a significant practical challenge, particularly in operating rooms where the patient is draped with surgical drapes. RFID technology does not have the practical issues that bar codes have, and some hospitals4 have recently implemented trial programs to monitor blood bags in order to track transfusions and guarantee that the right blood is delivered to each patient. Each bag of blood arriving at the hospital receives a self-adhesive RFID sticker in our smart hospital, as detailed in [Wes]. This chip has memory for recording a unique identification number as well as information on the blood type stored inside it. These numbers are also saved in a secure database that contains information about the blood's origin, intended use, and recipient once dispensed. When a nurse needs to prepare a blood transfusion, she uses a PDA with a reader to read the data encoded on the RFID chip in the blood bag as well as the patient ID bracelet. Before the blood can be used, the data from the patient and the bag must match. The overall process of managing blood bags is made easier and faster with this solution. Furthermore, the chance of patients getting the incorrect blood type is reduced[9].
- *Sophisticated Operating Rooms:* According to recent government studies, surgical identification may cause major difficulties, as stated in [Hen04]. The most frequently reported surgical mistakes, according to the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), were surgery on the incorrect body part or location, the wrong patient, or the improper surgical technique [Sen01]. The RFID technology is presently being tested on patients having ear, nose, and throat surgery [McC06] at the Birmingham Heartlands Hospital [Bir05][10]. The system's goal is to guarantee that the proper procedures are performed on the correct patients. Patients in the smart hospital are given an RFID-tagged bracelet that contains pertinent information as well as a digital image of themselves. The picture enables the clinical team to quickly check that they are dealing with the proper patient, and the computerized record guarantees that the operation is carried out correctly. If the incorrect patients are admitted to the operation room, the medical team is alerted automatically and immediately. As a result, radio tagging improves the safety and efficiency of the operating room. Furthermore, the danger of lawsuit as a consequence of surgical errors, as well as the expenses associated with them, should be substantially minimized.

- *Counterfeiting Protection:* Counterfeiting of pharmaceuticals is on the rise: counterfeit medicines endanger patients by containing hazardous chemicals; and pharmaceutical firms lose tens of millions of euros each year to the counterfeit drug trade . The United States Food and Drug Administration (FDA) issued a study [oHFA04] in February 2004 advocating the use of RFID to address the problem and urged the pharmaceutical sector to embrace the technology. Several big pharmaceutical companies launched pilots to integrate RFID into prescription medication packaging in conjunction with the FDA's statement. Pfizer, the maker of Viagra6, for example, intends to invest approximately € 4 million in a programme to provide RFID tags for bottles, cases, and pallets. The aim is to give each pallet, case, and package of medicines a unique number (the Electronic Product Code or EPC) and use that number to track all transactions involving the product. This creates an electronic pedigree that runs the length of the medication supply chain, from manufacturing to dispensing [Rob06]. According to [oHFA04], all manufacturers, wholesalers, chain pharmacy stores, hospitals, and the majority of small shops should have purchased and be utilizing RFID technology by December 2007. (i.e. antennas, tag readers, and appropriate information systems). As a result, customers will be able to obtain product codes and confirm their validity by accessing the manufacturer's database over the internet.
- *Keeping track of equipment, patients, employees, and documents:* RFID is unquestionably the finest technology for tracking applications out of all the possibilities. Assets, animals, and people may be tracked automatically and quickly with this technology. In a hospital, effective tracking opens up a slew of new possibilities. First and foremost, keep in mind that RFID readers are installed in strategic locations throughout our smart hospital, including major entrances, operating theater entrances, recovery rooms, medical history library exits, significant galleries, and so on. Together with the fact that all medical histories (and other critical papers) are tagged, we may utilize an assets tracking tool like the RFIDLocator to find them (see Section 3). This information may already assist in minimizing the loss of medical data. It's worth mentioning that, according to a short poll we did (see [Gui05]), such losses are not uncommon and may have serious repercussions, both financially and in terms of patient safety. Several document tracking solutions have previously been used with great success. The majority of them result in a good ROI (Return on Investment), such as the district attorney of Marin County (USA) saving 2500 man-hours per year [Swe05]. Furthermore, using an assets tracking tool as part of the infrastructure provided for our smart hospital allows us to easily identify and monitor both personnel and patients. This may help physicians, nurses, and other caretakers function more efficiently [Hen04]. It may also assist with real-time location, which is particularly useful in large buildings such as hospitals.
- *Preventing Medical Equipment Theft:* Hospitals are well-known for owning a large quantity of high-priced medical equipment. What is less well recognized is that a portion of this equipment is often stolen. According to a study [Ran06], more than e 155'000 items were stolen from eleven hospitals in the United Kingdom in 2005. According to a Harvard Medical School study, the Beth Israel Deaconess Medical Center (USA) loses about e 333'000 each year due to stolen and lost equipment [Sun05]. However, these studies do not account for the indirect costs of thefts. To begin with, a piece of equipment would have been searched for hours by hospital workers before being recognized as stolen. Second, some workers must re-order the missing items, distracting them from patient care or managerial duties. Theft does not just result in the loss of money. Theft of equipment may be critical, and its absence might have serious repercussions. These facts, according to [Ran06], have prompted the National Health Service of the United Kingdom to look at novel methods of safeguarding high-value materials.
- Radio Frequency Identification may once again assist in the search for a solution to this severe issue. Because RFID chips are integrated in our smart hospital's medical equipment, we can monitor and trace it (see Subsection 2.5 for more considerations about assets tracking within the smart hospital). This feature minimizes the danger of theft since the hospital's technical team is constantly aware of the whereabouts of materials inside the facilities. In addition, as with anti-counterfeiting (see Subsection 2.4), electronic tagging has a preventive impact and may aid in the identification of stolen goods. Furthermore, RFID gates at the hospital's entrances may assist in alerting security services that medical equipment has been removed from the premises. However, by establishing identifying processes for accessing or using the device, access control techniques (a very frequent application of RFID) may also assist. However, much like with anti-counterfeiting, the more entrenched the tags are in the substance, the more effective the RFID infrastructure will be in deterring thefts. Indeed, if the thief can simply (and without repercussions) delete the tags, the techniques described lose some of their usefulness. As a result, medical equipment manufacturers should implant the tags in the factory (on

demand or as a standard), or hospitals should be able to tag their assets with difficult-to-remove electronic IDs.

2. DISCUSSION

The growing complexity of managing today's healthcare settings is addressed by smart hospitals. On one hand, healthcare organizations are under pressure to provide high-quality patient care while simultaneously improving clinical outcomes and operational efficiency. Not to mention the fact that a typical "healthcare facility" consists of several buildings and a range of systems, such as data, networks, and construction technologies (such as heating, ventilation, air-conditioning, lights, and lifts, amongst others). Video surveillance, card readers, and emergency power source monitoring systems add to the complexity. A smart hospital should be designed with an accurate understanding of its medical staff's and patients' requirements in mind. A smart hospital must also be capable of dealing with a variety of difficult situations, such as pandemics. People, technology, and space are all characteristics of a smart hospital. Digitalizing procedures to improve cooperation between departments and streamline workflows inside the hospital, for example. Smart technology could help ensure that the right teams are activated quickly and that operating theaters are ready as soon as possible, resulting in higher patient survival rates. Making greater use of smart technologies to manage a hospital's resources. To ensure high standards of hygiene within the facility, a smart washroom solution that tracks usage and replenishment of consumables as well as monitors air quality could be implemented. Using smart solutions to improve time and space management in hospitals to ensure public safety. Medical waste may be handled and processed by intelligent logistics robots, minimizing human exposure and danger of infection. There is no one-size-fits-all solution for smart hospitals to succeed. It necessitates the sophisticated integration of a wide range of technologies, i.e., having systems "talk" to one another while absorbing and responding to input. For smart hospitals to function, disparate clinical, IT, and building technologies such as heating, ventilation, cooling, energy, fire prevention, nurse call, patient wards, operating theaters, security, telephone, and others must come together.

3.CONCLUSION

RFID is expected to expand rapidly in the healthcare sector. According to a recent study [Ser05], the RFID market in healthcare and pharmaceutical applications generated e 306 million in revenue in 2004 and is expected to reach e 1'916.6 million in 2011. This paper discusses a number of intriguing applications with potential futures. It also includes a demonstration of an open-source program that may be used to directly implement some of the use cases. It's worth noting, however, that some open issues must be addressed before the healthcare community fully embraces RFID technology. It's important to make sure that radio wave devices don't interfere with artificial hearts, heart monitors, or other electrical devices used in hospitals. Moreover, the impacts and side effects of radio waves on humans who are exposed must be clarified. When it comes to affixing radio wave tags to drug packages, there are concerns that exposure to electromagnetic energy will have an impact on product quality. In addition, any technology used in healthcare must address security and privacy concerns. However, because of the possibility of unintended wireless transmission of healthcare-related data, RFID raises special concerns. Individuals who are unethical could snoop on people and collect data on them without their permission or even knowledge. If RFID tags remain active after healthcare services are completed, this could happen. Staff at the hospital must be at ease with the fact that they can be tracked and located at any time. To combat the "big brother" effect and preserve individual freedom, perhaps some "RFID free zones" should be established. From these concerns, it should be clear that wireless transmission raises difficult cryptographic issues, and that clear laws and recommendations regarding the product tracking and people are required.

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