Medical Informatics in a United and Healthy Europe
K.-P. Adlassnig et al. (Eds.)
IOS Press, 2009

doi:10.3233/978-1-60750-044-5-720

Requirements for Radio Frequency Identification in Healthcare

Antti LAHTELA [1], Marko HASSINEN
Department of Computer Science, University of Kuopio, Finland

Abstract. Radio frequency identification (RFID) is a growing technology among different industries. As a technology, it has been used since the Second World War, but just in the last decade, the information technology (IT) community and healthcare have been taking more action on studying and developing the technology. In this paper, we represent the general requirements that healthcare sets for the RFID technology. The paper is a part of the research project MaISSI (Managing IT Services and Service Implementation) where our aim is to implement an automated identification system (AIMC) for our case hospital's medication care. The AIMC uses the RFID technology for patient identification and the bar code technology for medication identification. The system will automate the identification processes during medication administration, reduce medication errors and increase the patient safety.

Keywords. healthcare, medication care, RFID, patient safety

1. Introduction

Healthcare is under constant development. Improving safety, efficiency and quality brings productivity to separate healthcare processes and practices. To achieve this, healthcare has turned towards IT and its applications, as these can bring efficiency and help to healthcare professionals. Due to the vulnerability of treatment processes, it is lucrative to use IT applications for preventing errors and mistakes that humans can easily make. A large benefit of using IT in different operations is that it can improve the patient safety and nursing efficiency and therefore decrease the always notable healthcare expenditure [1].

It is not always easy to integrate new technologies into healthcare, because of its criticality and vulnerability. In hospitals, medical equipment and applications may encounter interference or compatibility problems between current and new technologies. If this happens, lives of patients can be endangered [2].

The main contribution of this paper is to represent the general requirements that healthcare sets for the RFID technology. The research questions are: what kind of requirements healthcare sets for RFID in healthcare and how can we respond to these requirements in the AIMC? The groundwork and data collection are based on earlier studies from the subject, participative observation made at the case hospital and results of workshops between our research group and the case hospital healthcare professionals.

[1] Corresponding Author: Antti Lahtela, University of Kuopio, Department of Computer Science, P.O. Box 1627, FI-70211 Kuopio, Finland; E-mail: antti.lahtela@uku.fi.

2. RFID

The *RFID* technology is comparable to the bar code technology where unique codes rely on optics and therefore require "line of sight", meaning that the bar code must be visible to the bar code reader. RFID uses radio waves, so the RFID tag can be invisible to the reader. Other differences between these technologies are that RFID can read multiple items simultaneously and RFID is more reusable as tags can usually be rewritten [3].

An *RFID system* consists of two main components: tags attached to objects that need to be identified and readers for reading/writing tag's information. In addition, a functional RFID system needs for its background a data system for handling the information from the reader [4].

3. RFID in Healthcare

There are different kinds of RFID applications for the use of healthcare professionals. Here are some interesting RFID projects in healthcare:

WISH (Wireless Information Systems for Healthcare) is an RFID and Wi-Fi-based system for healthcare in the United States. WISH is used for automating the work routines of healthcare professionals and reducing medication errors during medication administration. Using the WISH system is simple: a nurse logs into the system and starts his/her routine rounds at the hospital wards. At the patients' room, the nurse uses a PDA (which has an RFID reader) to read the patient's tag. The PDA is connected to the electronic patient record where the nurse can have the patient's information [5].

In a Taiwan hospital, RFID was used for locating and tracking SARS infected patients. This system also raised an alarm, when a new SARS infection occurred. In this case study, RFID was found to have the potential to operate efficiently for helping medical service and the patient safety [2].

At Harvard Medical School, Beth Israel Deaconess Medical Center, RFID and bar codes were used as a hybrid system. The system used active RFID tags for tracking equipment, patient beds, ventilators, IV pumps, electrocardiogram devices and volunteering staff. Passive tags were used to identify some patients, Neonatal Intensive Care Unit babies and mothers' milk containers. Bar codes were used for medication, most patients and staff identification. This study led project researchers to predict that RFID will eventually replace bar codes in the near future [6].

Tagging and tracking objects is one thing that can help the work in a hospital environment. Installing tags onto hospital instruments help healthcare professionals locating them quickly. In addition, hospital instruments and objects can be joined into same network, where they can be reserved for use or queried for their status (like in a library) [7].

In a hospital environment, the patient safety is critically important. There are lives at stake and no defects should be found. At the same time, hospitals are pressured to reduce costs and develop their processes. For identification, the RFID technology seems to offer some kind of a resolution as it is used to manage hospital patients, medications, medical processes, medical supply usage and outpatient compliance [8].

Different studies about RFID and healthcare show that the RFID technology brings benefits to the healthcare sector. Using RFID improves the patient safety, eliminates

paper-based documentation, prevents/reduces medical errors, increases productivity and efficiency, brings cost savings and reduces patient waiting time and so on [9].

4. General Requirements for RFID in Healthcare

Healthcare has its own restrictions and features for different technologies and applications. So, what are the requirements that healthcare sets for the RFID technology?

One problem with the RFID technology in healthcare is the electromagnetic interference. In hospitals, many medical devices use radio waves and nothing should disturb them, as the consequences can be severe. RFID uses radio waves and therefore all medical devices working on the same frequency as RFID, should be investigated or tested before taking them into action. Besides, in hospitals there are many compartments, wards, rooms and partitions with many walls and doors of different kinds of materials that may affect the usage range between RFID devices [2].

EMC (Electromagnetic Compatibility) is a standard for medical equipment, especially life-supporting equipment. It improves compatibility between hospital devices. The standard is valid only for equipment using frequency below 2.5 GHz (standard updated 2001) [10]. This standard sets critical requirements for RFID applications and devices that are functioning at the same frequency as the standard. Particularly life-supporting RFID applications must adopt this standard and comply with its requirements.

Hygiene is another issue that is important for hospitals. Nosocomial infections are a widespread problem and a big source of expenses. The hospital hygiene sets a simple requirement for the RFID technology: RFID devices have to be clean and cleaned after use.

Healthcare has its own requirements for secure data, because the information, stored inside on hospitals' data systems, is very critical and it can include highly sensitive information. It is important that all RFID devices and applications in a hospital environment are properly ensured and protected against unwanted security breaches. A good and a simple example of how the patient information on a tag is secured is to use a unique identifier on the tag. This identifier can be numbers, letters or a combination that reveals nothing to an outsider. The identifier is used to match it against a set of identifiers at the database where the actual information about the patient is kept. Figure 1 clarifies this procedure: the patient has a tag and a unique identifier (X123Y) installed into it. The tag is read by the RFID reader which will send the unique identifier to the data system. The identifier is compared with the corresponding identifier in the database and the matching information (John Doe) is sent back to the data system.

Figure 1. Use of a unique identifier on an RFID tag

Reading and writing operations between tags and readers should be 100% reliable and functional in RFID systems, especially in critical systems. For example, an unsuccessful reading incident, after a surgical operation where instruments are using

RFID, can create acute complication if some instrument cannot be found because the reader is not working properly [7]. This leads to a situation where all RFID systems must be carefully and extensively tested and piloted before they can be taken into real situations in a hospital environment. In addition, usability must be tested as well, because systems must be suitable for the use of healthcare professionals.

Case Study

The case hospital of our research project is one of the five university hospitals in Finland. Our future work is to implement an *automated identification system* (AIMC) for the case hospital's medication care. The AIMC system specifications are generated in 2008 and we will start the implementation phase during autumn 2009 in a one pilot ward. The AIMC is designed to use the RFID technology for patient identification and the bar code technology for medication identification. Figure 2 gives a general overview of the AIMC:

- A patient is nursed at the ward. He/she has a wristband integrated with RFID tag for identification. The automated dose-dispensing system (ADDS) at the hospital pharmacy has produced patient individual medications ready on doses (plastic bags). The ADDS can produce bar codes onto each dose to contain an identifier which refers to the information about the medications and the patient.
- A nurse starts medication administration. He/she has a PDA, integrated with an RFID reader and a bar code reader, as a data collection tool. The nurse reads patient's RFID tag and medication dose's bar code with the PDA.
- The gathered information from the identifiers is sent to a third party CFM (Care Flow Manager) system which will manage all the data concerning to medication care. The CFM system informs the PDA whether the right patient is receiving right medications. If everything is ok, the nurse can execute medication administration and it will be documented automatically to the CFM system.

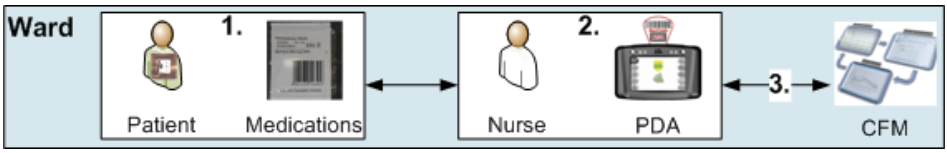

Figure 2. General overview of the AIMC

The general requirements for the RFID technology were represented earlier in this paper. Here are listed the same requirements and how we are going to solve these in the AIMC:

- **Frequency**. We will use 13.56 MHz frequency for RFID in the AIMC. We will first test the frequency to ensure, that it is suitable for the hospital environment and it won't interference any other medical equipment.
- **Cost**. The AIMC will use low cost passive RFID tags. There will be a bid for the RIFD suppliers to get the lowest price on the market.
- **Hygiene**. The AIMC and its elements will be protected with a protective material which will correspond to the hospital hygiene policy.
- **Data security**. A unique identifier will be used for securing the information in tags. The AIMC will work in the hospital Intranet.

- **Reader**. An RFID reader will be integrated into the PDA to have a compact yet versatile platform.
- **Usability**. The AIMC is specified to be a highly automated and process improving tool for the hospital healthcare professionals.
- **Reliability**. All the elements of the system will be tested during the implementation phase that nothing can go wrong in the production stage. The system will be sufficiently replicated to survive device breakage.
- **Integratability**. Integration will be implemented between the CFM system and the PDA.

5. Conclusion

In this paper we presented research that was aimed to finding what kind of requirements healthcare poses to RFID. Most of the requirements were general as in any demanding field such as reliability, security, co-operability with other data systems and low cost. More specific requirements set by the hospital environment were hygiene and the capability of operating without disturbing other electronic devices.

Although there are many obvious and some not that obvious requirements set to RFID solutions in healthcare, it seem that none of these requirements are insuperable. Hence, the RFID technology can be used in healthcare and many studies show that it can both improve the patient safety as well as streamline healthcare cost thus decreasing the workload and expense. As a case example, we presented a scenario in which RFID will be used for patient identification.

References

[1] Perrin, R., Simpson, N. (2004) RFID and bar codes – Critical importance in enhancing safe patient care. *Journal of Healthcare Information Management* 18(4):33–39.

[2] Wang, S.-W., Chen, W.-H., Ong, C.-S., Liu, L., Chuang, Y.-W. (2006) RFID applications in hospitals: A case study on a demonstration RFID project in a Taiwan hospital. In *Proceedings of the 39th Annual Hawaii International Conference on System Sciences HICSS'06*, 8:184a.

[3] Figarella, L., Kikirekov, K., Oehlmann, H. (2006) Understanding Radio Frequency Identification (RFID) in Healthcare: Benefits, Limitations, Recommendation. *A HIBCC (Health Industry Business Communications Council)*. White Paper.

[4] Al Nahas, H., Deogun, J.S. (2007) Radio frequency identification applications in smart hospitals. In *Proceedings of the Twentieth IEEE International Symposium on Computer-Based Medical Systems*, *CBMS '07*, IEEE, Washington, 337–342.

[5] Yu, W.D., Ray, P., Motoc, T. (2006) A RFID technology based wireless mobile multimedia system in healthcare. In *Proceedings of the 8th International Conference on e-Health Networking, Applications and Services, HEALTHCOM 2006*, 1–8.

[6] Halamka, J. (2006) Early experiences with positive patient identification. *Journal of Healthcare Information Management* 20(1):25–27.

[7] RFID Journal, 2002–2008, referred 2.2.2009, available http://www.rfidjournal.com.

[8] Wicks, A., Visich, J., Li, S. (2006) Radio frequency identification applications in hospital environments. *Hospital Topics* 84(3):3–8.

[9] Chowdhury, B., Khosla, R. (2007) RFID-based hospital real-time patient management system. In *Proceedings of the 6th IEEE/ACIS International Conference on Computer and Information Science ICIS 2007*, 363–368.

[10] Wallin, M.K.E.B., Marve, T., Hakansson, P.K. (2005) Modern wireless telecommunication technologies and their electromagnetic compatibility with life supporting equipment. *Anesthesia & Analgesia*, 101:1393–1400.