A Study of System Quality Attributes for RFID Application

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Abstract. RFID technology is to automatic identification and collects their data (auto-ID). It allows an object or person to be automatically identified at a distance using an electromagnetic exchange. In comparison to other well-known auto-ID technologies such as the barcode, RFID offers the following advantageous characteristics for the user. RFID technology is composed of an RFID tag and an RFID reader linked to a computer system. In this process, RFID become a useful technique. Therefore it is very important to know what the important factor in RFID is and what the quality and their relation for RFID is. This research aims to identity the quality for RFID system and makes a QoS model considering RFID's characteristics.

Keywords: RFID, quality attributes, QoS model, ISO9126

1 Introduction

Radio frequency identification (RFID) is an automatic identification and data capture technology which is composed of three elements: a tag formed by a chip connected with an antenna; a reader that emits radio signals and receives in return answers from tags, and finally a middle ware that bridges RFID hardware and enterprise applications [1]. Actually, in RFID, the first publications date back to 1948, it has only recently come to the awareness of the public. New auto-ID technologies, most notably RFID, have drawn the attention of many companies due to factors including: the need for more efficiency and security in supply chains, enhanced technologies, cost pressure, standardization initiatives, and prominent promoters such as Wal-Mart,Metro, and Tesco. When the Society of Information Management (SIM) conducted its last survey of IT executives, RFID was rated among the top 20 developments in application and technology [2]. Also this technology has great promise for diversified use in many industries with numerous practical applications. Much great potential have been realized and many are being explored. Predictably, a vast amount of academic research is being carried out in this field. Now, the time is right for an in-depth review of this technology, the academic research and the potential future use [3]. The purpose of this paper is to identify the quality attribute of

RFID system in industrial area and make their QoS model. System quality is defined as the degree to which a software component or system meets specified requirements and specifications. It is measured in terms of characteristics such as maintainability, reusability, etc. With the complexity of systems on the rise, there is an increasing need for measuring such quality characteristics at an early stage of the system software development cycle but this is not possible before the system is deployed and used for a certain period of time. However, the quality of system has attributes that can be used as good indicators of its characteristics. For example, reusability is one system quality characteristic that cannot be directly measured and complexity and volume are system attributes that can be measured and used as indicators of it. Several metrics have been proposed for measuring system attributes [4]. Very often, in correspondence of a service specification, several services may exist that match the specification. This means that there are several services offering the same piece of functionality, e.g., booking an hotel or returning a city temperature. The choice of the service to be invoked can be dictated by non-functional properties, i.e., a set of Quality of Service (QoS) attributes. One may decide to choose the cheapest service, the fastest, or maybe a compromise between the two. According to Std. ISO 8402 (ISO, 2002) and ITU (ITU, 1994), QoS may be defined in terms of attributes such as price, response time, availability, and reputation. Moreover, it may be possible to have some domain-specific QoS attributes: for example, an image processing service could have QoS attributes such as image resolution and number of colors [5].

Proposed QoS model to extract quality attribute from exist international standard and the other research model was considered with RFID characteristics. However, nowadays, this area research was much lacked. Therefore we extract their attributes from system qualities' and work to fit on RFID characteristics. The rest of the paper is organized as follows: Section 2 discusses about the RFID and exist quality attribute from the standard, Section 3 describes the proposed quality attributes for RFID and their QoS model, and Section 4 discusses about the Conclusion.

2 RFID and system quality attributes

2.1 RFID technology

RFID is a technology for automatic identification and data collection (auto-ID). It allows an object or person to be automatically identified at a distance using an electromagnetic exchange. In comparison to other well-known auto-ID technologies such as the barcode, RFID offers the following advantageous characteristics for the user [2].

- Unique identification: Applying, e.g. the "Electronic Product Code" (EPC) standards, RFID tags can identify classes of products as well as individual items.
- No line of sight: RFID tags can be read without direct line of sight even if the tag is covered, dirty or otherwise obscured from view.

- Bulk reading: If they are in range of a reader, multiple RFID tags can be read at the same time.
- Storage capacity: RFID tags can store significantly more information than just an identification number.
- Dynamic information: RFID tags with read–write capability allow information to be updated or changed whenever necessary.

RFID technology is composed of an RFID tag and an RFID reader linked to a computer system. The tag is the part that collects real time data and then transmits that data via radio waves.

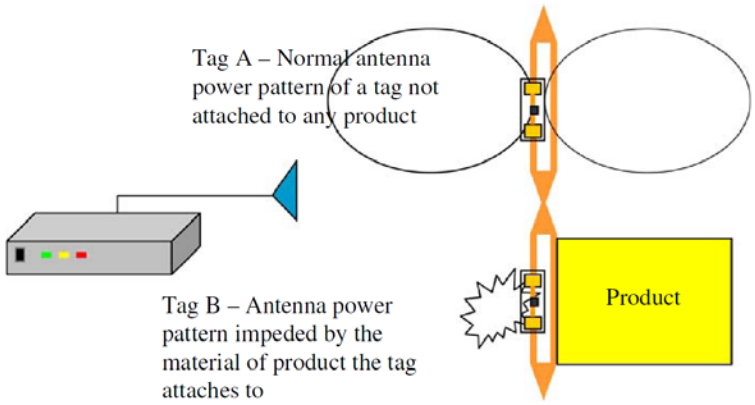

Fig. 1. Antenna power patterns of RFID tags

The tags usually have two parts, a small chip and an antenna. Information is stored and processed by the chip while the antenna is used to receive and transmit the information. The chip, in most applications, is used to store information about a product or a shipment. The object, product or shipment that is being tracked, is provided with a unique identifying number. This number is a part of the information that is stored in the chip that is embedded in the tag. All the relevant information about the object is gathered and stored in the chip. This information is read by an RFID reader when a tag passes by it. The information stored in a RFID tag is detected and recorded by the reader. The reader thus tracks the physical movement of the tag, and thereby that of the object to which the tag is attached. The reader, thus, can track the tag's movement in real time and pass its digital identity and other relevant information to a computer system. Currently, two types of RFID tags are in use: an active RFID tag which contains its own power source like a battery, and a passive RFID tag with no battery. For the passive RFID tag, the power comes from the signal transmitted by the antenna. The active RFID tags, on the other hand, have their own internal power source, which is used to power the chip and to broadcast the signal back to the RFID reader. Generally, the active tags have larger memories than the passive tags and have a much larger range of operations. Naturally the passive tags

are cheaper than the active tags [3]. Fig 1 shows an example of RFID tags usage for antenna power patterns [6].

2.2 System quality attributes

Much work has been done since about 1976 by a number of individuals to define a system quality framework. A quality model is defined as the set of characteristics and the relationships between them, which provide the basis for specifying quality requirements and evaluating the quality [7].

Table 1. ISO9126 quality model

Criteria	Sub-criteria
Functionality	Suitability
	Accuracy
	Interoperability
	Compliance
	Security
Reliability	Maturity
	Recoverability
	Fault tolerance
Usability	Learnability
	Understandability
	Operability
Efficiency	Time behavior
	Resource behavior
Maintainability	Stability
	Analyzability
	Changeability
	Testability
Portability	Installability
	Conformance
	Replaceability
	Adaptability

Quality measurement has also matured to the point at which a standard has been defined for this activity. The ISO standard for system software quality measurement defines the characteristics of system software quality as: functionality, reliability, usability, efficiency, maintainability and portability [8]. The ISO 9126 is part of the ISO 9000 standard, which is the most important standard for quality assurance. In this model, the totality of system software product's quality attributes is classified in a hierarchical tree structure of characteristics and sub characteristics. The highest level of this structure consists of the quality characteristics and the lowest level consists of the system software quality criteria [7]. An attribute is a quality property to which a metric can be assigned, but not all attributes have to carry a metric. According to the complete list of the ISO9126 quality model depicted in Table 1, there are six major criteria, namely functionality, system reliability, usability, efficiency, maintainability

and portability, along with their associated sub-criteria Functionality expresses the ability of a system to provide the required services and functions, when used under specified conditions, while reliability is an indication of the confidence that the system software will live up to the expectations. Usability indicates the understandability of system software as well as the easiness to learn and operate it. Efficiency is related to the performance of system software and maintainability to the means provided by the system software to be tested, upgraded and customized. Finally, portability indicates the level of adaptability/installability of system software product to different environments, as well as its conformance to related standards [9].

3 System quality attributes for RFID

Particularly, the sub-criteria was from Lee, Ho and Lau's model [10], such as Read range, Read accuracy, Identification, and Interference of *Functionality*, Data capacity of *Efficiency*, and Cost of *Business*. Data capacity has 100's-1000's of characters. In Read range, Passive RFID case has Up to 25 feet and Active RFID case has up to 100's of feet or more. Read rate has 10's, 100's or 1000's simultaneously. Read accuracy has 90% depends on relative orientations of reader and tag antennas and their polarizations. In Identification, it can uniquely identify each item/asset tagged In Interference, like the TSA (Transportation Security Administration) and some RFID frequencies do not like metal and liquids. It can cause interfere with certain RF frequencies. Cost normally has Tag 5¢ RFID startup kit with RFID reader, antennas, alien gateway software, startup kit tag and power supply/power cable USD 2595. In this research, we extract the criteria from ISO 9126 and Behshid et al.,[7] in order to identify the system quality attributes for RFID as shown in Table 2.

Table 2. Proposed system quality attributes for RFID

Criteria	Sub-criteria
Functionality	Suitability
	Read Accuracy
	Read range
	Read rate
	Identification
	Interference
Reliability	Maturity
	Recoverability
	Fault tolerance
Usability	Easy to use
	Understandability
	Operability
Efficiency	Time behavior
	Resource behavior
	Data capacity
Maintainability	Stability
	Analyzability

	Changeability Testability
Business	Cost

- *Functionality*: This sub-criterion indicates the ability of system software to perform according to its specifications. It measures the level to which the services and functions of the system software satisfy the users (system developers and re-users). In addition, the functionality characteristic attempts to evaluate the ability of system software to be reused (interoperability) and its ability to offer secure service according to user needs. It directly matches with the functionality criteria of ISO9126 but with different sub-criterion.
- *Reliability* refers to the system service developer's ability to successfully deliver requested service functionality. This ability can be quantified by the probability of success in a service execution, but it is usually evaluated through the service failure rate. This rate is calculated as the ratio of execution time and mean time between failures (MTBF). Similarly, there are also conflicting views on the execution time. From the service requester's perspective, the execution time should include both the duration of executing the system service and the time spent on functionality delivery. However, this definition is debatable because the service developer is not responsible for sustaining the entire network. Hence, it is reasonable to measure the execution time as the duration of executing the service only.
- *Usability*: Usability is "a set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users".
- *Efficiency*: Efficiency is "a set of attributes that bear on the relationship between the level of performance of the system and the amount of system resources used, under stated conditions." The efficiency of the time and resource behavior is distinguished. The time behavior describes for instance processing times and throughput rates while resource behavior means the amount of resources used and the duration of use.
- *Maintainability*: Maintainability is "a set of attributes that bear on the effort needed to make specified modifications."
- *Business*: Price is the cost of service for a request. It is always associated with the value of the system service's functionality, i.e. the more a service costs, the more complicated functions it provides. Typically, a non-free service is associated with service level agreements (SLA), which are legally binding contracts that guarantee the delivery of the functionality with promised performance.

Through this model and the criteria in Table 2, we make a QoS model for RFID as shown in Fig 3. This diagram shows that each attribute affect the other attributes. Example is, the *Reliability* can be improved when the *Functionality* is good.

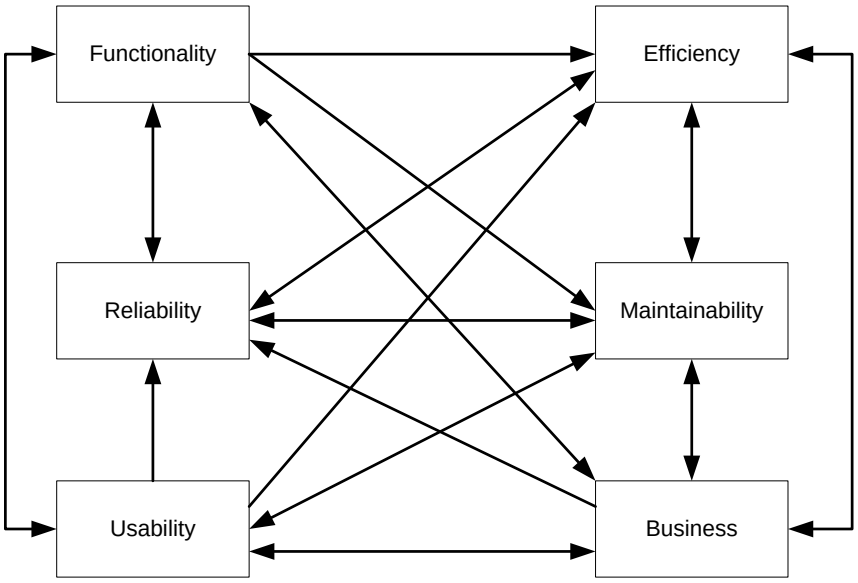

Fig. 2. Proposed QoS model for RFID system

5 Conclusion

RFID technology is an automatic identification using RFID tags and sensors. And it allows an object or person to be automatically identified at a distance using an electromagnetic exchange. In comparison to other well-known auto-ID technologies such as the barcode, RFID offers the following advantageous characteristics for the user. In order to efficiently use RFID system, it is necessary to exactly know what the quality attributes are and what their relation is.

In this research, we proposed quality attributes for RFID system and make a QoS model considering their relation. Proposed model consists of 6 criteria: *Functionality, Reliability, Usability, Efficiency, Maintainability and Business*. Each criteria was extracted from ISO 9126 and Behshid et al.,[7] considering RFID characteristics. By this attributes, we make QoS model with each relation.

References

1. Aysegul Sarac, Nabil Absi, Stéphane Dauzère-Pérès, A literature review on the impact of RFID technologies on supply chain management, International Journal of Production Economics Volume 128, Issue 1, November 2010, Pages 77–95
2. Stefanie Leimeister, Jan Marco Leimeister, Uta Knebel, Helmut Krcmar, A cross-national comparison of perceived strategic importance of RFID for CIOs in Germany and Italy, International Journal of Information Management 29 (2009) 37–47

3. Xiaowei Zhu, Samar K. Mukhopadhyay, Hisashi Kurata, A review of RFID technology and its managerial applications in different industries, J. Eng. Technol. Manage. 29 (2012) 152–167
4. D. Azar, J. Vybihal, “An ant colony optimization algorithm to improve software quality prediction models: Case of class stability”, Information and Software Technology 53 (2011) 388-393
5. Gerardo Canfora, Massimiliano Di Penta, Raffaele Esposito, Maria Luisa Villani, A framework for QoS-aware binding and re-binding of composite web services, The Journal of Systems and Software 81 (2008) 1754–1769
6. N.C. Wu, M.A. Nystrom, T.R. Lin, H.C. Yu, Challenges to global RFID adoption, Technovation 26 (2006) 1317–1323
7. Behshid Behkamal, Mohsen Kahani, Mohammad Kazem Akbari, “Customizing ISO 9126 quality model for evaluation of B2B applications”, Information and Software Technology 51 (2009) 599-609
8. Andrea Capiluppi, Cornelia Boldyreff, Karl Beecher, “Quality Factors and Coding Standards - a Comparison Between Open Source Forges”, Electronic Notes in Theoretical Computer Science 233 (2009) 89-103
9. Andreas S. Andreou, Marios Tziakouris, “A quality framework for developing and evaluating original software components”, Information and Software Technology 49 (2007) 122-141
10. C. K. M. Lee, William Ho, G.T.S. Ho, and H.C.W. Lau, Design and development of logistics workflow systems for demand management with RFID, Expert Systems with Applications 38 (2011), pp.5428-5437
11. W. H. DeLone and E. R. McLean, The DeLone and McLean Model of Information Systems Success: A Ten-Year Update, J. of Management Information Systems, vol. 19, no. 4 (2003), pp.9-30.