Network and Complex Systems
ISSN 2224-610X (Paper) ISSN 2225-0603 (Online)
Vol.4, No.1, 2014
www.iiste.org

The Impact of Radio Frequency Identification Detection in Cellular Networks

Chigozirim Ajaegbu
Computer Science Department, Babcock University, Nigeria.
ajaegbuc@babcockuni.edu.ng

Oreoluwa Adesegun
Computer Science Department, Babcock University, Nigeria.
adeseguno@babcockuni.edu.ng

Adekunle Y.A.
Computer Science Department, Babcock University, Nigeria.
adekunleya@gmail.com

Abstract

Radio Frequency Identification Detection technology (RFID) is a convenient and automatic instrument of identification and detection. It's application can be extended to cellular network. Cellular network is a form of radio technology that makes used of radio waves for its functionality. It major goal is to cover a larger geographical area without the use of cables. It has been observed that cellular radio failures in base station has not being given due attention by researchers in terms of improving quality of service. The failure of cellular radios can hindered or suspend easy exchange of calls between users and could sometime lead to distorted billing from the operator's end. This study takes a look on some current studies in RFID while the major aim was focused on the need to enhance cellular network performance through the using RFID technique. An analytical method was employed through the use of a mathematical model to demonstrate how RFID readers can be used to monitor tagged cellular radios with a given region.

Keywords: radio frequency identification, cellular networks, radio waves, rfid tags, rfid readers

1. Introduction

Cellular network is a form of radio technology distributed over a geographical region known as cell. Each cell is serviced by at least one fixed transceiver usually referred to as a base station. The unpredictable failure of radios situated in base stations, has become a concern that in the sense that past, present and future studies in the direction of cellular network have paid less attention to this issue. Also, there is a need for service operators to focus their maintenance attention towards quick response in this direction for this, will not only improve their Quality of Service but will also improve their revenues.

Though, RFID makes use of tags and readers, it is a wireless form of technology which uses the same technique as the cellular and satellite communication, it is a technique that identifies objects through radio communication.

Over the years, various traditional means of object detection code such as bar code have been used but RFID technology provides a convenient and automatic mode of not only detecting objects but also offers a means of identification.

Though RFID has been in talk for many years, much advancement has been in place in the chip manufacturing technology in order to accommodate new applications (Ilie-zudor *et al*. 2006). The performance, manufacturing cost and applications determine the nature of RFID in terms of properties and restriction. Some of the existing applications of RFID are access control using proximity cards, electronic product codes and contact-less payment systems (Ilie-zudor *et al*. 2006).

2. Overview of RFID

The idea of RFID started some centuries ago with some scientists such as Michael Faraday with the discovery of inductance and James Clerk Maxwell with the formulation of electromagnetism equation. Other works include that of Heinrich Rudolf with the validation of Faraday and Maxwell's predictions Weis, A.S (2012).

Some existing technologies, like Electronic Article Surveillance (EAS) systems were commercially in use by some companies in order to keep surveillance to their products. It consists of magnetic devices attached to the

product. These are deactivated when the products are sold. In a situation where there is an attempt to steal products, as soon as the culprit tries to exit, an alarm is triggered in order to notify the system administrator and all concerned of such an attempt. This type of EAS system has its setback in the sense that, it cannot be used to identify objects like the RFID technology.

Research has shown that the most popular and successful auto-ID system is the Universal Product Code (UPC). UPC is a one-dimensional and optical barcode identifier. Though optical barcodes are fast, reliable and convenient to use, it has its setbacks attached with the packaging process, where there can be an interrupt during the process. It also uses line-of-sight for its operation meaning that any obstruction in its part may result to difficulty in reading the object data. Also optical barcode needs the human invention for it to be of optimal performance.

RFID does not required a line-of-sight for it application and does not require the intervention of human manipulation in order to align the reader with tag. Research has also shown that various forms of readers and tags classification exist (Ilie-zudor *et al*. 2006)

3. Review of Relevant Literature

Galhotra and Lane (2009) looked at the application of RFID technology in Libraries. Their paper recognized the challenges of reluctance in efficiency, increased data entry errors and staff's strenuous task in book identification, sorting, conveying and theft detection of library books and aimed at demonstrating how the RFID technology can be applied in libraries in order to achieve efficiency, reduced data entry errors and reduced workload on staff. Thus their specific objectives were to take an insight in RFID technology, to look at how it can be applied in libraries and to look at the likely merits and demerits of RFID in libraries. These were achieved through a descriptive survey of the RFID technology, the various functions and roles of each of the components play in achieving a well-coordinated library settings and functions. Though, their paper demonstrated the usefulness of RFID in achieving a well-coordinated book identification, self-checkout, proper sorting, conveying of books and theft detection in the library, it failed to suggest how one of the disadvantages (reader deceit), which can occur as a result of jamming two tag signals can be mitigated.

Ilie-zudor *et al* (2006)looked at RFID and its current applications and noted that despite the introduction of the technology since past generation, application range for its practical implementation failed to be exploited. Their paper aimed at exploring more practical application range of RFID which was broken down into some specific tasks such as: review of the underlining principle of RFID, insight on the future prospects and challenges and some promising application areas. These were achieved through the review of the underlining principle of RFID, classifying RFID tags and readers in terms of technology and principle of operation. At the end of their work, some proposed application areas of RFID were suggested such as item instance or item class identification, location identification and data transfer from or to the RFID tag. Though a setback in terms of technology collision was noted in their paper but it failed to suggest possible solution to counter such scenarios.

Su *et al* (2007) in their paper pointed out the need for every enterprise to identify and monitor their enterprise operation flows. This according to their paper could be achieved through proper insight and intelligent prediction of the movement of their business objects or in essence the general status of their business objects. The identification of data should automatically be captured and integrated into the different enterprise process application in real-time, though bar-code technology has been the forefront technology, but cannot be used to achieve real – time visibility because of its low speed in reading data, its line-of-sight technique and the unavoidable involvement of humans. Thus, the need for a technology capable of eliminating these limitations in order to achieve a real-time visibility in enterprise operation flows. Their paper took a look at a comparative study of creating Automatic Identification and Data Capture (AIDC) Infrastructure via RFID as against other technologies such as Bar-code and sensor technology. This led to their various specific objectives such as taking an insight on Bar-code system, RFID and sensor technology alongside their respective pros and cons, identification of various components in an AIDC infrastructure and identification of some challenges attached with creating RFID oriented AIDC infrastructure. They achieved these through a survey of the various mentioned technologies and also an insight in the commonly used AIDC infrastructure with its components identified and modeled out. Though a means of obtaining a more reliable AIDC infrastructure using RFID along with sensor technology was proposed, their paper did not give due consideration to the likely conflict that may occur as a result of attempting simultaneous reading and identification of items.

Tian, Wang and Zhang (2010) in their paper on design and application of the RFID technology in Enterprise Resource Planning (ERP) mainly discussed how to fill the gap of inability of real time information in ERP

systems by the adoption of RFID technology. The module if incorporated in an ERP systems will yield proper management, as administration would be able to make informed decision and not on mere speculations. They came to this result by reviewing existing systems which at the time did not have an RFID module. A feasibility study of their proposed system was also conducted along with the description of their system using storage information system as case study. Though their paper recognized the value of RFID technology in their work but failed to detail some of the likely challenges that would be faced if their proposed system is implemented. Some of these challenges would include:

Security: Are competing companies going to be able to read each other tags? Would the tags still be transmitting even after those goods get to their client?

Range of Operation of the RFID module

Collision and Jamming of Signals of multiple RFID tags sending/receiving from the RFID reader.

Are there going to be standards for manufacturers of RFID tags and readers for easier implementation?

Saxena and Doctor (2008) in their paper radio frequency identification: application and Indian scenario took a descriptive survey of RFID technology and its industrial applications using India as a case study. Some of the applications of the technology detailed in the paper include application in the manufacturing industry; Application in warehouse management; Application in the medical and health care environment; Application in animal identification and Application in education such as its use in the library.

The paper proposed the application of the RFID technology in other areas such as water and electric billing systems which had not yet been implemented in India. Again this paper failed to highlight what happens when several RFID tags are sending information to a RFID reader or when there is intentional jamming of signals by a malicious person.

Kochar and Chhillar (2012) detailed the need for an effective data warehousing system where data sent to the data warehouse is without unnecessary duplicate or noise when RFID technology is being used in any of its application. In other to achieve this goal the paper showed an in-depth review of related works which led to their proposed model for data management (cleaning, transformation and loading).

4. RFID Systems and System Performance

RFID systems have been designed in such a way that its mode of operation adopts different frequency range. The nature of the system will determine the range of signal coverage, signal power requirement and performance. In an RFID system, the identification of only the serial number is not really enough to provide adequate information that is been required of the product. The major grip of RFID is the backend system that keeps additional information of the description of the product and where and when a certain tag was scanned (Jechlitschek, 2006). The backend consist of database and well defined interface application used in retaining RFID readers scan tags information. see figure 1: when new update is received by the backend, it adds it to the database and can also perform some form of computation/other operations.

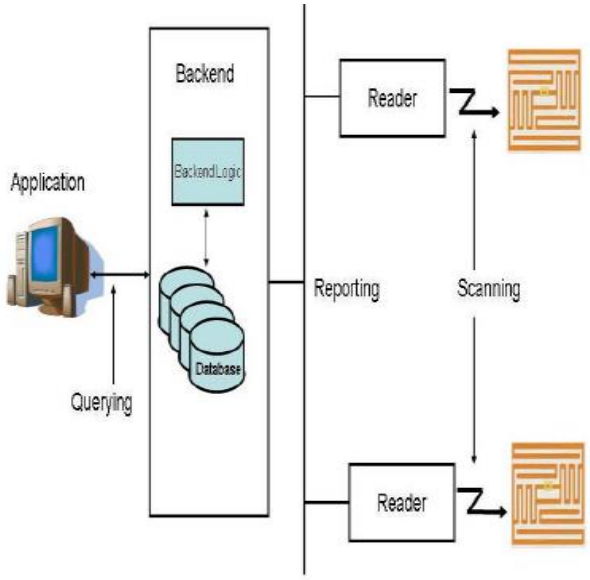

Figure 1: A simplified RFID system (Adopted Jechlitschek, 2006)

Ajaegbu and Adesegun (2013) opined that, RFID has shown superiority over the common magnetic bar code in various ways

Such as:

a. It is cost effective and has limited or no error in data collection compare to the magnetic barcode that requires human intervention and a high possibility of human error.
b. RFID is not restricted to a particular direction since it does use line -of- sight technique.
c. RFID can store very large amount of data when compared to magnetic barcode.
d. It can also work with sensors
e. It has a unique identification property compared to the barcode technology.

SOME POSSIBLE CHALLENGES WITH RFID

Ajaegbu and Adesegun (2013), outlined some of the possible challenges with RFID technology as follows:

Security:

The operation of RFID system within a defined frequency location requires that the scanner and the reader have to be within the frequency range for the identification to occur. Though, this can be one of the criteria, its challenge being that access could be given to any reader operating within similar frequency range by the tag. This means that some individuals can be illegally monitored thereby exposing some of their personal information. This is a situation where the RFID system is being implemented on human beings.

Standardization:

There should be some form of standardization committee to monitor the distribution of frequency allocation of RFID. This will help to reduce some form of interference and collision with other operating frequency ranges.

Cost of Implementation

The high cost of implementing RFID is pretty on the high side that most companies will not want to embark on it.

5. RFID and Cellular Network

RFID technology application can be extended to cellular network in terms of monitoring failure radios. This technique can be implemented using point process. In this regard, the tags and readers can be modeled in the context of regions. The idea is to have the various transmitting radios tagged with a monitoring reader(s) at the operator's backend. The function of these readers is to issue out an indicator for any non-transmitting cell radio. In order to demonstrate this, a mathematical model is been used.

5.1 Model

Let Q be a fixed number of tagged transmitters in a given location such that Q is placed at random locations inside a bounded region W C R2, let x1 ….. xi be i.i.d (Independent and identically distributed) random tags, with uniform distribution in W.

This implies the probability density of each xi is given as

$$f(x) = \begin{cases} \frac{1}{\lambda 2}\ (W)\ if\ x \in W \\ 0 \qquad otherwise \end{cases} \tag{1}$$

Where λ2 (W) denotes the area of W

With each random point xi being uniformly distributed in W, we have for any bound set β C R2.

$$\mathbf{P}\,(X_i \in \beta) = \int_B f(x)dx = \frac{\lambda_2\,(\beta \cap W)}{\lambda_2(W)} \tag{2}$$

In order to demonstrate the monitory technique of RFID readers over Q

Let α TX1(β) represent the number of RFID readers mapped towards the transmitters falling in β. it implies that α TX1(β) + α TX2(β) +,……, α TXi(β) = α (β).

Note: the counting variables α(β) for different subsets β are dependent. This implies that if β 1 and β 2 are disconnected, then

$$\alpha(\beta 1) + \alpha(\beta 2) = \alpha\,(\beta 1 \cup \beta 2) \leq Q \tag{3}$$

so that α(β1)and α(β2) must be dependent. It then means that:

$$\alpha(\beta) = \sum_{i=1}^{n} 1\{Xi \in \beta\} \tag{4}$$

From this, it means that the RFID reader α (β) has a binomial distribution with transmitters Q and

$$P = \frac{\lambda_2(\beta \cap W)}{\lambda 2(W)} \tag{5}$$

(probability that the bounded set β occupies a certain area).

From theorem, it can be established that the joint distribution of (α(β1), α(β2)) is the multinomial distribution on m test with success probabilities (P1, P2) where

$$Pi = \frac{\lambda_2(\beta \cap W)}{\lambda_2(W)} \quad (6)$$

Source: (Adapted from: Baddeley, Barany, Schneider and Weil, 2004)

6. Conclusion

The idea of RFID technology could be used to shield more light in the cellular world. There is a need for cellular operators to keep abreast of their cellular radios installed for various base stations. This will help them to be able to detect any failing radio on time and implement immediate recovering measure. This study showed how RFID can be mapped to group of cellular radio randomly placed in a given region. Again, it will help operators to reduce the stress of running around in order to monitor failure radios for repairs and maintenance since every base station radios can comfortably be monitored from the operators end. This model is still subject to further testing and verification.

REFERENCES

Ajaegbu C & Adesegun O. A. (2013) "Radio Frequency Identification Detection Collision Mitigation Technique". *International Journal of Advance Research in Computer Science*. **4**, p22-25,.

Jechlitschek, C (2006) "A Survey Paper on Radio FrequencyIdentification (RFID) Trends" Retreived on 29/11/2012 From file://X:\www-docs\cse574- 06\ftp\rfid\index.html,.

Galhotra, M . K and M.S Lane, M.S (2009) "Application of radio frequency identification technology in Libraries". *Journal of Library & Information Technology*, **29**, p59-64, .

Tian, J , Wang, X and Zhang, L (2010) "Design and application of the RFID technology in ERP. Computer and Information Science", **3** pp264-267,.

Kochar, B and Chhillar, R (2012) "An effective data warehousing System for RFID using novel data cleaning, data transformation and loading techniques". *The International Arab Information Technology*, **9** pp 208-216,.

Saxena, M and Doctor, G (2008) " Radio frequency identification (RFID): Applications and Indian scenario". *The Icfai University Journal of information Technology*, pp72-78,.

Su, X, Chu C, Prabhu, B.S and Gadh, R (2007) " On the creation of automatic identification and data capture infrastructure via RFID". *Auerbach Publications, Taylor & Francis Group*. pp24-43,.

Ilie-zudor , E , Kemeny, Z , Egri, P and Monostori, L (2006) "The RFID technology and its current applications". *In proceedings of the Modern Information Technology in the Innovation Processes of the Industrial Enterprise-MITP*,.

Weis, A.S (2012) " RFID (Radio Frequency Identification): Principles and Applications". Retrieved on 12/11/2012From:http://www.google.com.ng/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC8QFjAA&url=http%3A%2F%2Fciteseerx.ist.psu.edu%2Fviewdoc%2Fdownload%3Fdoi%3D10.1.1.182.5224%26rep,

Baddeley, A, Barany, L, Schneider, R and Weil, W (2007) "Stochastic Geometry: Lecture Notes in Mathematics" Springer, Springer-Verlag Berlin Heidelberg, pp 2-9