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Concurrency Control Technique in RFID Implementation

Ajaegbu C, Idowu S.A, Omotunde A .A and Abel S.B
Computer Science Dept. Babcock University

Abstract: Database techniques have been used to proffer solution to some challenging situations that has to do with management of data in industries. This idea can also be valuable and implemented in managing the operation mode of some devices during the design level stage. The proposition of Radio Frequency Identification Detection technology as a convenient and automatic instrument of identification and detection has shown value in usage in the society. However, it has been identified with some challenges such as collision despite its prospects. The need to mitigate collision between a reader and multiple tags is of importance for effective deployment of the technology. The paper aimed at integrating one of the concepts of database management technique of concurrency control known as Time-Stamp (TS) in order to offer solution to the problem of collision in RFID implementation. This paper adopted a small scale business scenario which was used to illustrate the benefit this stands to offer in the real-life implementation. The paper concluded by arguing that this technique can be adopted and implemented and by such doing, will enhance further the performance of RFID technology.

Keywords: Radio Frequency Identification, Wireless sensor networks, Database Management, Concurrency Control, RFID tags, RFID readers

I. INTRODUCTION

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.

RFID is the use of wireless form of technology to transfer data from a tag on an object to a reader with the help of a radio frequency electromagnetic signal or simply put, it is a technique that identifies objects through radio communication.

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 [8]. 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 [8].

A new technology similar to an RFID system that will also operate in the license frequency region similar to cellular network is about to be born. This technology will also make use of tags and readers. The readers will be design in such a way that it can read and write signals sent from the tags. With due consideration to the range of coverage, it will be limited as there is no form of repeaters implementation yet. In the course of this technology, there could be overheads in trying to access signals coming from various tags to the reader at the same time. One major technique that can be used to prevent such collision at arises due to concurrent sending of signals by the tags is the idea of a Time Stamp (TS) concurrency control protocol.

1.1 An 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 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, see Table 1&2:

Table 1: Classification of RFID tags (adopted from Zudor Kemeny, Egri & Monostori, 2006)

Passive	-Also called 'pure passive', 'reflective' or 'beam powered' - Obtains operating power from the reader - the reader sends electromagnetic waves that induce current in the tag's antenna, the tag reflects the RF signal transmitted and adds information by modulating the reflected signal
Semi-passive	- Uses a battery to maintain memory in the tag or power the electronics that enable the tag to modulate the reflected signal - Communicates in the same method as the other passive tags.
Active	- Powered by an internal battery, used to run the microchip's circuitry and to broadcast a signal to the reader - Generally ensures a longer read range than passive tags - More expensive than passive tags - The batteries must be changed periodically
By the tag's memory type	
Read-only	- The memory is factory programmed, cannot be modified after its manufacture - A very limited quantity of data can be stored, usually 96 bits of information - Can be easily integrated with data collection systems - Typically are cheaper than read-write tags
Read- write	- Can be as well read as written into - Its data can be dynamically altered - Can store a larger amount of data, typically ranging from 32kBytes to 128kbBytes - Being more expensive than read-only chips, is impractical for tracking inexpensive items
By the method of wireless signal used for communication between the tag and reader	
Induction	- Close proximity electromagnetic or inductive coupling – near field - Generally use LF and HF frequency bands
Propagation	- Propagation electromagnetic waves-far field - Operate in the UHF and microwave frequency bands

Table 2: Classification of RFID readers (adopted from Zudor; Kemeny; Egri; Monostori, 2006)

By design and technology used	
Read	- Only reads data from the tag - Usually a micro-controller-based unit with a wound output coil, peak detector hardware, comparators and firmware designed to transmit energy to a tag and read information back from it by detecting the backscatter modulation - Different types for different protocols, frequencies and standards exist
Read/write	- Reads and writes data from/on tags
By Fixation	
Stationary	The device is attached in a fixed way, for example at the entrance gate, respectively at the exit gate of products
Mobile	In this case the reader is a handy mobile device

1.2 Previous Related Works

Galhotra MK & Lane MS [2] 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 E *et al* [7] 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 X *et al* [6] 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 J *et al* [3] 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:

a. 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?
b. Range of Operation of the RFID module
c. Collision and Jamming of Signals of multiple RFID tags sending/receiving from the RFID reader.
d. Are there going to be standards for manufacturers of RFID tags and readers for easier implementation?

Saxena M. & Doctor G. [5] 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 B. &Chhillar R. [4] 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 cleaning, data transformation and data loading.

2.0 RFID SYSTEMS AND SYSTEM PERFORMANCE

Different RFID systems operate in different frequency range. The type or nature of the system determines the range of signal coverage, 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 keep additional information of the description of the product and where and when a certain tag was scanned [Jechlitschek C, 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.

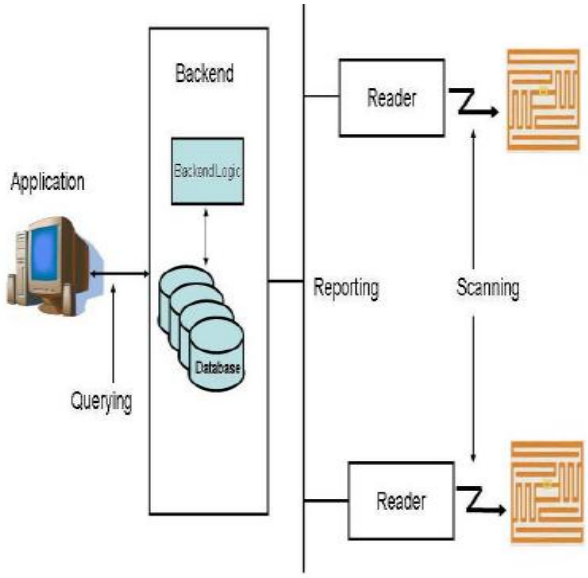

Figure 1 : A simplified RFID system (adopted from Jechlitschek C, 2006)

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.

2.1 Some Challenges With RFID

A. 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.

B. 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.

C. 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.

III CONCURRENCY CONTROL OPERATION OF RFID

A time stamp concurrency control protocol is use to assign various times to transactions trying to gain access to a data. Let assume Ti to be a set of active transaction (T1,T2,…….Tk) and assume the accessible data to be B. this for each individual transaction a time stamp of TS(Ti) is assigned to it. In such doing, there will be some form of conflict serializability such that as T1 is access Q, no other transaction should till the time allotted for T1 has elapsed. This imply that for tags T1,T2, T3 and T4, a time stamp is set in such a way that there will be some form of serialization (i.e. $T1 < T2 < T3 < T4$), in the other, in which the time stamp is place by the concurrency control manager. In a situation where T1 could complete its transaction with Q, may be due to some form interruption or disruption caused by some form of impediments, the concurrency control manager is expected to reschedule T1 in such that $TS(T1) > Tn + 1$. That is the maximum TS(T1). With such practice, a new RFID could be born that will eliminate any form of collision between various tags and reader transactions. A practical example is a shopping mall, where the various goods are being tagged and the reader positioned in such a way that it is free from disruptions.

Case 1

Assume buyers of different type of goods to be buyer A, buyers B and buyer C. Assume buyer C to pick his product first followed by buyer A then buyer C. As buyer C picks, the reader reads the product type which will automatically write it to the backend system (i.e. the database system of all the goods in the mall) for an automatic assignment of a time stamp say TS(T1). So it does also for the rest of the goods until a conflict serialization is established.

Case 2

Assume a situation where two buyers say buyer C and buyer A pick their different product at the same time i.e TS (C) = TS (A). In this case, the reader automatically readjusts itself by captioning the two signals using a locking technique in a form that will appear as if the reader is using a buffering technique. The priority will be base on the value of the goods and this process has to be one that will occur in a millisecond. By so doing, there could be some form of check in case the technology process is been compromised.

One of the greatest advantages that could be gain from this form of technology is the ease of putting check to any attempt of stealing any good(s) from the shopping mall.

IV CONCLUSION

The occurrence of RFID collision can be eliminated by applying to form of modification in the design process. NRFID is set to add more value to the current existing technology through the integration of the technology with database time stamp concurrency control technique. this also will enhance cost effectiveness as there would be need to have more than one reader and one backend system as in the case of the shopping mall analogy. The demonstration of this technique and the intending outcome will be demonstrated in our forthcoming article.

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