Radio Frequency Identification (RFID) Technology: Gaining A Competitive Value Through Cloud Computing

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ABSTRACT

Radio Frequency Identification (RFID) uses radio waves to track the movement of goods through the Supply Chain system. The identity of an object is captured with a unique serial number that is transmitted wirelessly to a computer system. Small businesses are facing RFID implementation barriers. The barriers range from the perspective of the consumer-goods manufacturers and retail organizations. We propose implementing RFID technology using cloud computing framework to alleviate or reduce the implementation cost which is the most prevalent barrier.

Keywords: Cloud computing, RFID, Implementation, Barriers, Bar codes, Tagged product

INTRODUCTION

The Radio Frequency Identification (RFID) technology is an emerging valuable tool to automating identification and inventory management in supply chains. Radio frequency identification appears as a tag, containing the electronic product code (EPC) data including various details about the tagged product. Since the potential applications of RFID systems are numerous, especially in supply chain management, it is essential to address the industry and the consumer perspective issues and mandates that have resulted in barriers to RFID implementation.

This technology is being adopted widely for various applications worldwide and at the same time the technology has certain issues that are hindering its implementation in many organizations as well as its exponential growth. Secondly, expanded deployments of RFID systems in big organizations are taking place because of adoption of the RFID technology. As a result, more infrastructure (hardware and software), cost, services, and storage facilities are required. Additional barriers range from a lack of industry-wide standards, understanding of total costs, adoption of appropriate/necessary infrastructures to consumer privacy violation concerns. All leave organizations and consumers weary of the benefits and uses of the technology.

RFID can provide competitive advantage to retail organizations, yet purchasing such new technology, with the infrastructure costs of building out an RFID system, is a big investment, and in most cases, too large of a barrier to overcome (Gluckman, 2005). In order for retail organizations to implement a fully operating RFID system, they will need such technology components as tags and antennas, readers and networks, and networked databases. A typical mistake made by retail companies is the assumption that the acquisition of the technology is the main expense. As implementation standards and best practices remain in the early stages, the largest component of the total cost of implementing a complete RFID system in-house is professional services. These services include consulting services, architecture design, platform selection, integration, and installation and management. In fact according to The Yankee Group, the initial services component of an RFID system is 80% of the total cost of implementation (Gluckman, 2005). More specifically, small and mid-size organizations are disadvantaged significantly due to these barriers.

With our proposed cloud computing RFID implementation, the retail organizations, specifically the smaller and midsize companies, would not need to establish all these new IT infrastructures mentioned above in order to implement RFID because they are very expensive. Many smaller and midsize companies cannot afford them thence they are hindered to deploy the RFID technology in their organizations. Cloud computing has come for their rescue.

Cloud computing refers to computational resources that are accessible as on-demand services over the network. It may be broadly categorized as software-as-a-service, platform-as-a-service, and infrastructure-as-a-service (Napper and Bientinesi, 2009). The software-as-a-service (SaaS) which is also known as application-as-a-service includes the process of any application being delivered over the platform of the web to an end user, typically leveraging the application through a browser. It is based on the traditional timesharing model where many users shared one application and one computer (Dabas and Gupta, 2010). It leads to cost savings and risk reduction since a big amount of capital expenditures are eliminated which were required in the deployment of infrastructure or large-scale applications in-house (Napper and Bientinesi, 2009).

In this paper we outline the various barriers in implementing RFID technologies, and propose the implementation of RFID using Cloud Computing technology to mitigate the challenges posed by these barriers.

MOTIVATION

An RFID tag is a small and inexpensive microchip (like the size of a grain of salt) that emits an identifier in response to a query from a nearby reader. Once it is attached to an object, the small radio can send information specifically about the object to a computer network. The Electronic Product Code (EPC) is a unique number that identifies a specific item in the supply chain and it is this EPC that is stored on an RFID tag. Once the EPC is retrieved from the tag, it can be associated with dynamic data such as from where an item originated or the date of its production or it's current location.

In 2003, Wal-Mart made it mandatory for its top 100 suppliers to put RFID tags on all cases (Juels, et al, 2003) and pallets that roll out of the manufacturer's base. The Department of Defense has ordered its suppliers to make all the supplies RFID enabled and Gillette has ordered at least 500 million of these. Michelin, which manufactures 80,000 tires a day, is planning to put RFID tags in each of its tires (Juels, et al, 2003). There is no law requiring a label indicating that an RFID chip is in a product; every item purchased with an RFID tag is "numbered, identified, catalogued and tracked."

Since many organizations require their vendors to supply RFID tagged products, the competitive race began so much that small and medium size companies could not cope or afford the cost and challenges of implementing full-fledged system of RFID. Thence, we propose that RFID technology be hosted in the cloud so as to enable small and medium size companies to subscribe to on-demand services or pay-as-you-go which will not be cost or capital intensive. This will help these companies to survive instead of being crunched.

BENEFITS OF RFID TECHNOLOGY IN BUSINESSES

Due to its speed, range and durability, RFID has made a place for itself in high-end technologies and businesses, while the relatively cheaper and easy to use barcode is widely used in everyday applications, specifically by small and medium enterprise (SMEs). There are no tight controls on where an RFID tag should be positioned. Unlike barcode labels, which need to be read automatically and must adhere to standard positioning, the only requirement for the RFID tag is that it must be within the field of the reader and not blocked by metals or water. Additionally, the reader can read numerous tags at the same time. RFID tags provide robustness and security for asset, document and software tracking, but it doesn't have to stop there.

Companies are increasingly realizing the potential for RFID technology to be used in patient and people tracking, within the supply chain, in retail and in manufacturing; when used for tracking assets, RFID can greatly reduce the loss or misplacement of goods, minimize shrinkage and provide additional security for tagged items. Moreover, E pedigree, pharmaceutical, event ticketing and airline baggage tagging will also see business benefits.

Many organizations such as the U.S. Department of Defense, Toyota, Pfizer, Wal-Mart and a number of retail stores currently utilize RFID systems as part of their supply chain processes. Wal-Mart, in particular is often highlighted as an exemplary in the industry for their successful deployment of RFID technology in the early 2000's. RFID technology has significantly contributed to Wal-Mart's low cost strategy by allowing them to create an inventory control system that is highly efficient. Another retailer that has experienced a return on investment with respect to implementing an RFID system is American Apparel, a clothing retail chain headquartered in Los Angeles, CA. American Apparel boutiques regularly display over 26,000 Stock-Keeping Units (SKUs) which limits them to displaying a single article of clothing in a given color or style on the sales floor at a time. The use of RFID tags on all items coupled with handheld readers allows employees to determine which items are on the sales floor versus the stock room. This system has reduced the time that was traditionally spent dealing with inventory by more than 90%.

Similarly, Giant Food Supermarkets and Pharmacies have strategically put RFID technology into practice. The following were reported by Mr. Newborn, a former stock clerk at Giant Food Inc. (Brock & Laryea, 2009) regarding the deployment of RFID technology as it relates to inventory control:

- Shortened ordering process which would normally take approximately 3-4 days of ordering products throughout the week. But this is now automated, so it is done within a matter of minutes
- Significant decreased the number of employees needed for inventory control
- More accurate form of documenting inventory, less mistakes than with manual entry by humans
- Automatically created sales reports, so the managers could easily track performance

OTHER BENEFITS OF IMPLEMENTING AN RFID SYSTEM

There are several benefits for companies who are implementing RFID technology in their business processes:

- Improves overall supply chain performance primarily because it provides managers with real-time data that enhances decision-making: Enables effective Materials Management & Inventory Control by reducing bottlenecks in the flow of materials, which ultimately ensures that products are located at the right place at the right time and consequently helps to reduce inventory levels and minimize overstocking warehouses and distribution centers.
- Facilitate contingency planning and proactive practices: Allows forecasting demand for goods more accurately since these estimates are based on real-time data. Business managers are thus able to sense vulnerabilities at an earlier stage and act upon them in a timely manner.
- Improve and strengthen customer-supplier relationships by fostering communication and information-sharing between business firms, suppliers and customers. Inventory management is enhanced as the tags and readers can be programmed in such a way that an automatically signal is sent when replacement orders are needed. The two-way communication makes it possible for timely shipment of orders; a key priority for customers.
- Mitigates costs by reducing the time and labor needed to manually input data. These systems improve data accuracy, which directly benefits sales and operations planning and is a practical way to help firms stay afloat given the current economic climate. A brief discussion on cost savings is provided in the next section of this paper.
- Cost Savings: Estimated savings of at least 30% of the 2 to 4% in operational expenses that organizations typically spend on warehouse and distribution costs.

IMPLEMENTATION BARRIERS

Lack of Industry Standards

One main challenge organizations encounter with RFID implementations is lack of industry standard. Although the use of RFID technology is not new, only recently an industry-wide adoption of the technology is developing. Once retail organizations, like Wal-Mart, began requiring certain vendors to supply RFID tagged

products, the race to become RFID compliant began, though, not without the issue that the mandates came before the standards were developed. Due to this, implementation has been hampered by high costs and unreliable hardware which has resulted in manufacturers and retailers being reluctant to invest heavily until worldwide standards are established.

According to Mohsen Attaran (2007), RFID technology faces implementation challenges such that implementing full-fledged systems in a large manufacturer can cost from $13 million to $23 million. Considering the sheer cost of RFID implementation, there is no ROI (Return On Investment) for the technology if you pursue compliance.

According to a survey conducted by AMR Research, manufacturers and retailers site a lack of maturity in standards as a main challenge in implementing RFID technologies. Although 44% of the respondents polled believe that the maturity of today's RFID standards is enough to deliver a return on investment, only 29% of process manufacturers believe the standards have reached an 'appropriate level' of maturity and only 35% of the large companies with more than 5,000 employees believe standards are mature enough to deliver their investment returns (Sullivan, 2005).

Industry leaders also believe that once core and next generation standards are developed, the costs related to RFID implementation will be greatly reduced and thus allow smaller organizations to realize the return on investments that are sought by the larger organizations.

Those companies that have adopted a 'wait-and-see' approach due to lack of understanding and standards need a strategy to aid them in embracing and integrating the technologies. EPC global and other standards approval organizations must thus work with the RFID 'users' to develop standards that are appropriate for organizations of different sizes and in different industries.

CONSUMER-GOODS SUPPLIERS AND MANUFACTURERS

Another barrier exists due to a basic lack of understanding of the approaches to integrating the technology into the existing IT infrastructure. Though commonalities among RFID implementations exist, it is specific to companies based on their size, industry, and relationships to other business. For example, a manufacturing company (supplier) that will be placing RFID tags on its products will have different implementation needs than the retail company that receives the tagged products. These consumer-goods manufacturers, initially will be most concerned about 'how' to efficiently modify their warehouses and production lines, and how to tag products and/or pallets with the RFID tags, while retail companies will initially be more concerned with processing the data received from the tagged products.

Manufacturing companies must implement the approach that best fits and will satisfy their business needs. Without a clear understanding of the different approaches to being RFID compliant, these organizations will remain resistant and not overcome barriers to implementing RFID technology into their business operations.

RETAIL ORGANIZATIONS

For retail organizations, the real value and return on investment of RFIDs comes from how the information derived from RFID tags and systems is applied to enterprise applications that control core business processes (inventory management, supply chain management, warehouse tracking, and location control applications) (Sullivan, 2005). To realize the benefits of RFID, retailers will need to upgrade their IT infrastructure in a number of areas, and their interfaces with other business will have to be closer. In addition, centralizing the above RFID functionalities and integrating them with legacy systems will require a new level of systems integration capabilities. With cloud computing, retailers will not need to upgrade their IT infrastructure.

The challenge of combining the components of the individual parts of RFID together in a smooth and reliable manner is one barrier for IT organizations. In many ways, deploying RFID is analogous to deploying a whole new IT infrastructure, with new data sources, processing mechanisms, recipients, network capabilities

implemented where none were previously needed and a new category of devices to communicate with and manage (Williams, 2005).

Another problem is that, RFID creates huge volumes of data that are difficult to manage. According to an estimate, an RFID system can generate 10 – 100 times the data of conventional barcode systems, causing a huge increase in the daily volume of data on the corporate IT system. Recently, RFID retailers have made a great deal of noise about the massive hardware costs required to deal with mountains of data created by RFID systems (Winans, 2005).

Although manufacturers and retailers are preparing to fully embrace RFID technologies, knowledgeable consumers are reluctant. Organizations lack of address to the RFID unknowns and misconceptions have created tremendous privacy concerns that are preventing consumers from accepting the new technology.

Most retailers claim that they are applying RFID to track and trace goods from the manufacturing plant to the store and onto the shelf. They also claim that it's about product data, not customer data. Many informed consumers however, claim the technology could endanger privacy by allowing remote tracking of people and what they own, carry or have bought. In fact, a study released by Britain's GMB union, claimed RFID and satellite technology were violating the privacy of up to 10,000 UK warehouse staff and other supply-chain workers. The study, carried out by the University of Durham, said the technology, which has been deployed by firms including Tesco, Sainsbury's, and Asda, allows RFID readers to be tracked by managers, creating conditions similar to "prison surveillance." The GMB is now calling for safeguards to prevent its members' privacy being compromised (BPM Today, 2005).

After the creation of consumer organizations and pending legislation against RFID, companies are now attempting to overcome this barrier by starting to address the privacy issues presented by their consumers. In fact, after being hounded by Katherine Albrecht, founder and director of Caspian (Consumers Against Supermarket Privacy Invasion and Numbering), a New Hampshire homemaker turned RFID-detractor-in-chief, Italian fashion chain Benetton and U.S. retail giant Wal-Mart announced they would, at least for now, use RFID tags in storerooms but keep them out of their stores (Black, 2005).

PROPOSED RFID CLOUD COMPUTING IMPLEMENTATION

RFID technology is being adopted widely for various applications worldwide and at the same time the technology has certain issues which are hindering its implementation in many organizations as well as its exponential growth. Secondly, expanded deployments of RFID systems in big organizations are taking place because of adoption of the RFID technology. As a result, more infrastructures (hardware and software), cost, services, and storage facilities are required.

For example, one main challenge organizations encounter with RFID implementations, as we mentioned above, is lack of industry standard. This lack of standard results into heavy amount of implementation cost, simply because, since retail organizations like Wal-Mart requires their vendors to supply RFID tagged products, the race to become RFID compliant began. According to Mohsen Attaran (2007), RFID technology faces implementation challenges such that implementing full-fledged systems in a large manufacturer can cost from $13 million to $23 million. Considering the sheer cost of RFID implementation, there is no ROI (Return On Investment) for the technology if you pursue compliance.

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The focus of this paper is to attach the cloud computing mechanism to the existing RFID technology and thereby propose the RFID implementation using the cloud system to solve the aforementioned problems.

Meanwhile, we want to list few of the benefits many organizations are gaining by deploying cloud computing in their systems such as:

- The cloud paradigm has the ability to offer new capabilities for every developer, but especially for those developers involved with implementing applications with the intensive demand of complex enterprise applications or high performance computing for science or research projects.
- There are many benefits for cloud computing. In fact, many companies use it, including Amazon, Yahoo, Google, Zoho, Microsoft and Sales force. This is becoming the norm in computing and software deployment. It helps keep the cost down for both the users and website owners. Also for the users, they can access it from any computer and still have the file they need. For the owners, they do not need to reproduce the software and ship it out. They just rent the server space.
- Likewise, IBM has introduced the IBM Smart Business Development and Test on the IBM Cloud. That service is designed to provide developers with a secure, cloud-based enterprise-class development and test environment, thus offering them the ability to create and test very large enterprise-scale applications without the acquiring, configuring, or maintaining the hardware needed. And that's an important point. When asked to identify the top benefit of deploying applications in a public cloud the most cited were: freedom from maintaining hardware (19.9%), cost savings (19.4%), and scalability (16.4%). If we look just at those developers in large companies (having more than 1000 employees), the results are the same, though there is less emphasis on scalability.
- Scalability: IT departments that anticipate an enormous uptick in user load need not scramble to secure additional hardware and software with cloud computing. Instead, an organization can add and subtract capacity as its network load dictates. Better yet, because cloud-computing follows a utility model in which service costs are based on consumption, companies pay for only what they use.
- As the technology is highly scalable (load balancing, hardware upgrades, etc), website expansion can be done with minimum limitations. Think about the hassle of migrating your website from a shared server to a dedicated server; think about server crash when your website experienced a sudden surge – all these problem can be avoided easily by switching to cloud hosting.
- Mobility, like most networks it allows users to connect even without their own computers, meaning you can do your work from anywhere in the world as long as you have a internet connection and a computer access. So you can take your work with you on your wedding and vacations.

So, there are plenty of benefits working with cloud computing. Cloud computing is still growing and many government bodies and company organizations already use this type of network for their businesses. This type of computing allows them to focus on what matters and not to worry about technology side of things.

COST SOLUTION USING RFID CLOUD COMPUTING IMPLEMENTATION

Since, cost is one of the barriers in implementing RFID, now with the cloud computing, clients will be able to use the RFID technology based on-demand thereby paying small about of fees as needed. This goes a long way to alleviate the burden of investing huge amount of money in the new infrastructure.

Take for instance, many business application software vendors are pushing for the use of the hosted software model for Small and Medium size Enterprises (SMEs). The goal is to help customers acquire, use, and benefit from the new technology while avoiding much of the associated complexity and high start-up costs (Stair and Reynolds, 2010). Many software producing giants like Microsoft, Oracle, NetSuite, etc, are among the software vendors who offer hosted version of their Enterprise Resource Planning (ERP) or Customer Relationship Management (CRM) software at a cost of $50 - $200 per month per user (Nichols, 2008). This pay-as-you-go approach is appealing to SMEs because they can experiment with powerful software capabilities without making a major financial investment. Organizations can then dispose of the software without large investments if the software fails to provide value or otherwise misses expectations.

By the same token, RFID can be hosted in the cloud to enable its usage by small and medium size organizations or any organization that cannot afford the cost of implementing the entire technology. Since the RFID implementation has been hampered by high costs and unreliable hardware which resulted in many organizations

(manufacturers and retailers) being reluctant to invest heavily in the technology, the pay-as-you-go approach and/or the on-demand services approach will enable them believe that the maturity level of RFID is enough to deliver a return on their investments.

STORAGE SOLUTION USING RFID CLOUD COMPUTING IMPLEMENTATION

As stated above, one of the implementation problems is that RFID creates huge volume of data that makes it difficult for organizations to manage. But, on the cloud, the RFID data is semantically filtered according to a specific application of need, use its relative platform and infrastructure over the network and then stored on a specific server. Middleware and protocols are used in the cloud computing system here. A server administers the system and traffic. The middleware and protocols allow the networked resources to communicate with each other. The cloud computing systems has a lot of storage space which it requires to keep all its RFID systems clients' information stored. It makes a copy of all the RFID information and stores it. The copies enable the central server to access backup machines to retrieve data that otherwise would be unreachable. Now as a result of using cloud computing, the huge amount of data which was lost earlier at very early stages as a result of lack of storage and because of bearing low priority in the semantic inference may now be preserved and processed on the cloud to draw more intense conclusions (Dabas and Gupta, 2010).

Also, one of the biggest advantages associated with cloud computing as a web hosting solution is the idea of ***elastic capacity***. Demand for more bandwidth and disk space is always elastic, either up or down. As the demand increases, it is necessary to have more server resources at your disposal. As it decreases, paying for those unused storage resources could be an unwanted burden. In order to have a web site capable of dealing with high traffic spikes, you need to ensure that there are enough server resources to handle the influx. When web traffic has ebbed, you will maintain better profitability if you do not have to pay for those additional resources you needed during the spikes. Rarely does any website have a constant level of increasing spikes.

That notwithstanding, cloud computing (depending on the provider and the plan chosen) charges are for an amount per gigabyte of transfer and per web site request. The pricing is very straightforward and easy to understand for the most part. This pricing structure helps define cloud computing as a ”pay as you go” plan, allowing one to be able to harness as much or as little server resources as are necessary. This elasticity for meeting traffic demand is one of the biggest distinguishing characteristic of cloud computing. While the market is dominated by a select few number of players currently, it is poised for RFID to become more popular, with several well-known traditional hosting centers to offer cloud based solutions.

In general, cloud computing provides computing service that is scalable and virtualized and reduces the capital cost of IT by converting capital expense into operating expense. It is web based. Another advantage frequently discussed regarding cloud computing is the better stability that such plans usually come with. Since the cloud is interconnected, there are many different instances for redundancy. This redundancy and the associated scale make cloud computing quite stable. Very rarely is there a problem and even when one arises, it’s usually quickly resolved. This significant increase in the level of stability means that you can have more piece of mind about whether your website and online applications are up and running. This type of service is what the organizations using RFID technology need.

CONCLUSION

In this paper, we propose the implementation of RFID technology using the cloud computing system, which provides on-demand services and pay-as-you-go system. This appeals to Small and Medium size Enterprises (SMEs) because they can now use such powerful RFID capabilities without making a major financial investment. Cost being the major barrier in implementing RFID by many organizations, with cloud computing system as well as consumer acceptance issues as drivers, these organizations will now gain competitive values in the supply chain system and the barriers discussed in this paper can be mitigated and circumvented.

In the absence of addressing the cloud computing issues, other successful implementation and acceptance of RFID technologies will continue to prevent companies from achieving the ROI that the technology promises. In

addition, without the elimination of these barriers, new innovations that RFID technology can bring will not be realized.

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