RFID
Invaluable Technology or a New Obstacle in the Marketing Process

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Introduction

Seeking a sustainable and defensible competitive advantage has become the priority for any manager competing in the international marketplace (Morgan & Strong, 2003). The bases for success are abundant and the source of competitive advantage can be found in the firm's ability to differentiate itself from competition in the eyes of the customer. Another strategic direction to reach competitive advantage for a firm is to operate at a lower cost and hence at greater profit than competition (Porter, 1990, 1996; Christopher, 1998). New technology for supporting logistics management in the supply chain has the potential to assist the organisation in the achievement of both a cost and a value advantage. Such new technology can be the implementation of RFID technology into the supply chain (Glover and Bhatt, 2006).

There have been many conferences and seminars during recent years about the implementation of RFID (Radio Frequency IDentification) technology. In others the implications for retailers, packagers and brand owners have been discussed. Wal-Mart's decision for implementation of RFID by its suppliers will probably force many firm's to develop strategies for its use within the actual supply chain (Tutorial-Reports.Com, 2007). Even firms that are not facing supplier mandates are now taking serious interest in the new technology (RFID news, 2007a). The RFID technology has suddenly become a hot industry with many new expectations for solving intelligence problems within international distribution systems and retail chains (Sandberg, 2006). Despite the expected influence on many industries the implementation of RFID technology has reached little research interest from a managerial point of view. One recent study has been conducted about the implementation of RFID in relation to barcodes in libraries (Yu, 2007). Another study has previously discussed RFID and the innovation cycle (Sheffi, 2004). The intention with this paper is therefore to address marketing issues with such new technology within a supply chain. The aim with the paper is to contribute with an analysis of feasibility studies in relation to the structure and application of RFID technology in a supply chain. The RFID device serves mainly the same purpose as a bar code or a magnetic strip on a credit card. A significant advantage of RFID technology is that the RFID device does not need to be positioned precisely in relation to the scanner or swiped through a special reader. A main disadvantage has been the price of the device in relation to the package e g juice package. The first research question in this paper refers to - how can RFID technologies contributes to competitive advantage for a single supplier in a supply chain. The second research question refers to – which are the implications of the technology from a marketing point of view?

The RFID technology is based on an automatic identification method relying on storing and remotely retrieving data using devices in the form of tags or transponders. An RFID tag can be attached to or incorporated in a product or package but can also have many other applications e g in passports (Aval, 2006). The purpose with the tag is for storing or tracking information about a product or package with the help of using radio waves. Chip-based RFID tags contain silicon chips and antennas. Tags that are passive do not require any internal power, whereas tags that are active require a source of power. However, in contrast there is also a growing consumer concern about the implementation of the radio frequency ID tags in shops since consumer groups are concerned about the possibility that suppliers use the tags for monitoring consumers once that they have left shops with their purchases (Capgemini, 2005). The RFID technology has obviously become an important development project in many areas but the break through is supposed to come when the price has reached such a level that it can be used for general transport and distribution systems. Areas that are of special

interest refer to use within packaging of food and other commercial goods and thereby replacing bar codes. One of the big opportunities by using the technology is the flow of information that can be transferred in the supply chain between the supplier and the end customer (Glover and Bhatt, 2006).

The new technology can be an important device for reaching competitive advantage for firms in the supply chain, but customer reactions can also be an obstacle and encumber the introduction of new technology and thereby delay the introduction of products. The active or passive tag can either be incorporated in the product, or package of the product. Another possibility is to incorporate the tag in a pallet for monitoring purposes during the passage of the supply chain. In many product areas it seems that supplier wants to implement the tag in the package (e g consumer electronics, food products), whereas consumer interests are concerned about implementation into the product itself due to the risk of monitoring the use or consumption of the actual product.

An increasingly interesting direction to achieving a cost advantage comes not necessarily from reaching volume by economies of scale, but through logistic management. In several industries cost represent such a significant proportion of total costs that it is possible to make major cost reductions through fundamentally reengineering logistics processes (Christopher, 1998). Another strategy is to base the commercial activities on service excellence. This can be supported by using new technology for reaching better responsiveness and reliability from suppliers by reduced lead times, just in time and value added services. RFID can be an important device in supporting different logistic processes by giving the possibility to introduce added value services in the supply chain. Competitive advantage can thereby be derived from the way in which firms organise and perform activities within the supply chain. In order to gain competitive advantage over its rivals a firm must deliver value to its customers through performing activities more efficiently than its competitors, or by performing the activities in a unique way that creates greater differentiation in relation to competitors (Barney, 1991; Peteraf, 1993; Slater, 1996; Christopher, 1998). The RFID technology can support such processes by reaching a higher efficiency in the supply chain.

The RFID (Radio Frequency IDentification) Technology

Manufacturers and other actors (e g retailers) in a supply chain have traditionally used bar-coding as a way to track and keep control of products in a logistic system. Bar-coding use a digital language to encode data so that it may be read optically by a computer based scanner. Bar-coding has several advantages in relation to manual handling in terms of data accuracy, data transfer speed and flexibility. A main disadvantage of bar-coding is that each item either a single product, batch or truck need to be scanned manually, even though many attempts have been made to automate scanning procedures with mixed results. Another disadvantage is that bar-coding can only store a limited amount of information. A third disadvantage is that when a tag is printed, the information contained in the tag can not be changed. New information requires a new tag. Harsh environments can also damage the tag so it can not be read by a scanner. Even if the RFID technology is not new and was used e g by the British to track planes and vehicles during World War II, several large retailers are now looking at the technology as a mean to effectively manage their supply chains (Glover and Batt, 2006). The RFID technology creates a readable and rewriteable tag system for goods as they move along the supply chain. The technology gives the opportunity to create smart products that can feed information in to the supply chain in an automated fashion (Boström, 2006). A RFID system has three basic components such as an antenna, a transceiver (with decoder) and a transponder

(RF tag). Data is generated and stored by a computer in a similar way that a bar code system. The antenna generates a magnetic field which activates the magnetic tag and enables communication between the tag and the transponder. In many cases are the antennas and transceivers packed together as a reader. The range of the system is depending on the tag (transponder) and the operating frequency. Low frequency systems have shorter reading distance and lower system cots, whereas high frequency systems can reach higher scanning speeds and distances, but also at a higher cost.

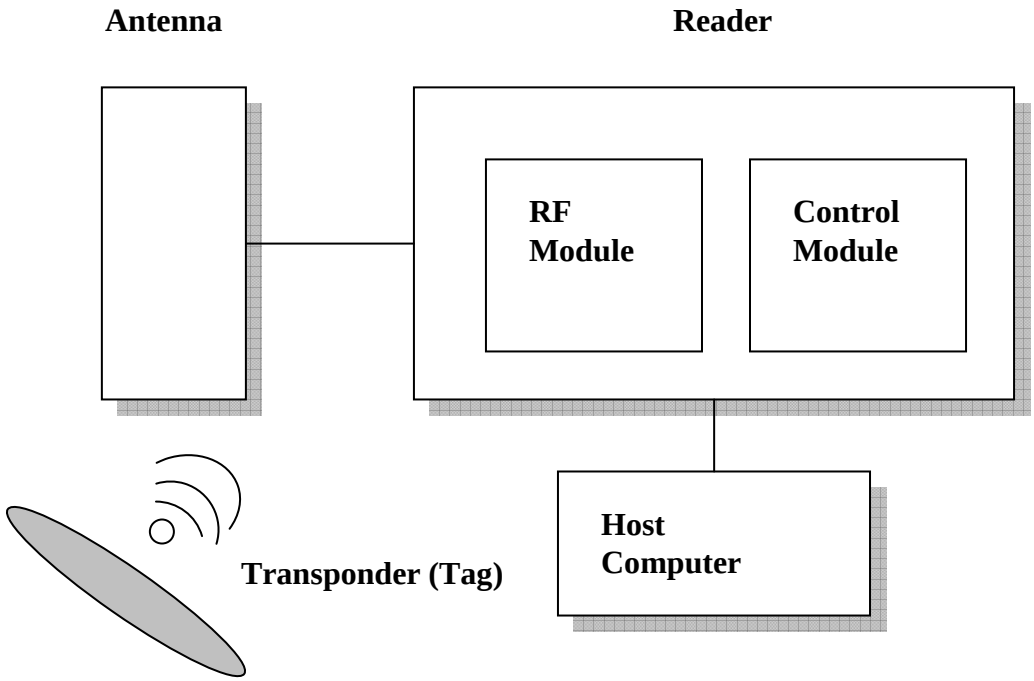

Figure 1: Basic RFID system

The RFID tag contains an integrated circuit where information can be stored. Tags are either in an active or passive format, where active tags surround a power supply. Active tags have read-write capabilities, greater memory capacity and a better range than passive tags. On the other hand active tags are bulkier and more expensive than passive tags and their lifetime are limited. Passive tags are similar to bar codes since they normally are read-only. Passive tags have also lower memory capacity and lower operating distance. However, they are much less expensive and more durable and smaller than active tags. Even though technical and costing are different, they can be made in an unlimited number of configurations for different applications. When a RFID tag on a product or in a batch passes within the operating distance of a reader, it detects the reader's activation signal via the antenna. The reader decodes the actual encoded data from the tag's integrated circuit and the data is passed to the host computer for further processing. This enables the actor that have invested in an active system to use the RFID tag to actually contribute to the process with information in the supply chain by e g delivery instructions or inventory information.

The RFID technology can contribute with several advantages for actors in a supply chain (Meredith, 2006). One of them is that RFID technology does not require direct contact, or visual contact to operate properly. Tags can be read in different environments and other harsh conditions. The new generation of readers enables the user to read the tags very quickly

(responding in less than 100 milliseconds) and have also the ability to read multiple tags simultaneously. This gives the opportunity to scan an entire area of inventory in a stock instead of scanning each unit separately. One of the most important advantages with RFID systems is the capability of enabling product surveillance since inventory can be tracked at any point in the supply chain. In stead of communicating supply and demand for a product at every point in the supply chain, RFID technology enables the possibility to create a network of actors that can communicate with each other. Products can communicate with machines but also with other products and shelves can track their own inventory level and send a signal when it is necessary for a refill. Recent technology developments have brought prices down and conductive inks for printable tags and antennas are new developments that will enhance the application base for the RFID technology.

Market for RFID Systems

Even if RFID technology has been functioning since the Second World War (since the 1920s) significant technology advances in recent years have spurred widespread interest and adoption of the technology across several industries. Among the technology advances the main contributions are smaller tags and improved scanning devices which have contributed to reduced costs for implementing RFID solutions. As firms become more adept at leveraging their IT infrastructure they are also looking at other possibilities for reaching competitive advantages from investments in technology. With reduced costs for RFID technology and renewed motivation for using technology for improved efficiency many new applications are emerging. Bar code is the primary technology that RFID may replace in the future but as the costs of the technology continue to decline its application are certain to grow. Initially used for military applications RFID technology is now available for many applications within the commercial sector like transportation and distribution; commercial trucking and railroad companies to track their fleet and for tracking commercial products within a supply chain. Other applications concern toll systems; car parking and tracking individual products or cattle.

The possibilities for application of RFID are numerous and by implementing this technology firms can achieve cost savings as well as improving the service they can provide (Oldeén, 2006; Rehn, 2006). Even though RFID technology can be used within many areas the most obvious impact are supposed to be among e g retailers in the area of inventory management. When Wal-Mart called for its top 100 suppliers to begin providing pallets to its stores with tags by early 2005 they started a new era in supply chain management. This directive caused suppliers in the supply chain to focus on implementing RFID technology and to find necessary solutions. This was only the beginning of the Wal-Mart evolution in this area and many more suppliers were tagging pallets and boxes and some individual items by the end of 2006. RFID offer practical benefits to any firm who needs to keep track of physical assets and suppliers can improve their planning and execution by incorporating the technology in the supply chain.

Obstacles for Introducing the Technology

One of the largest technological obstacles for the implementation of RFID technology in the retail sector or any other industry is the lack of world wide standard format. If for example each retailer uses a different format the cost of implementation may be prohibitive. However, industry organisations are working in favour of a standardisation even if single retailers might be unwilling to share their competitive advantage reached by more efficient inventory tracking or supply chain efficiency. Another obstacle is associated with RFID scanners and

tags. RFID tags emit UHF waves which are absorbed by water and other liquids and the waves are also reflected by metals which can lead to incorrect reading. Still other suppliers may refuse to comply with a strict implementation schedule due to high costs associated with developing it. The adoption by big retailers like Wal-Mart and Tesco will serve to drive down the costs of tags, an argument that can be used to convince other actors about the benefits for investing in a new technology.

The Industrial Network

RFID could transform some activities in the supply chain and the most obvious impact will be on actors (e g retailers) in relation to the area of inventory management. Firstly, RFID can be used as a compliment to bar-coding and track products or pallets with products throughout the supply chain. This will give actors enhanced supply chain efficiency in relation to prevailing approach cost by scanning different items. RFID has also the impending of decreasing human error in inventory management since there is no need to scan items individually as they pass through a supply chain. This will also have an effect on the total amount of work necessary for handling different items in the supply chain. With more accurate information about changes in demand streams management will be in a better position for making quicker and more efficient decisions about stock levels. This can enable management to eliminate inventory loss through error and theft, but it can also give management a better overview of

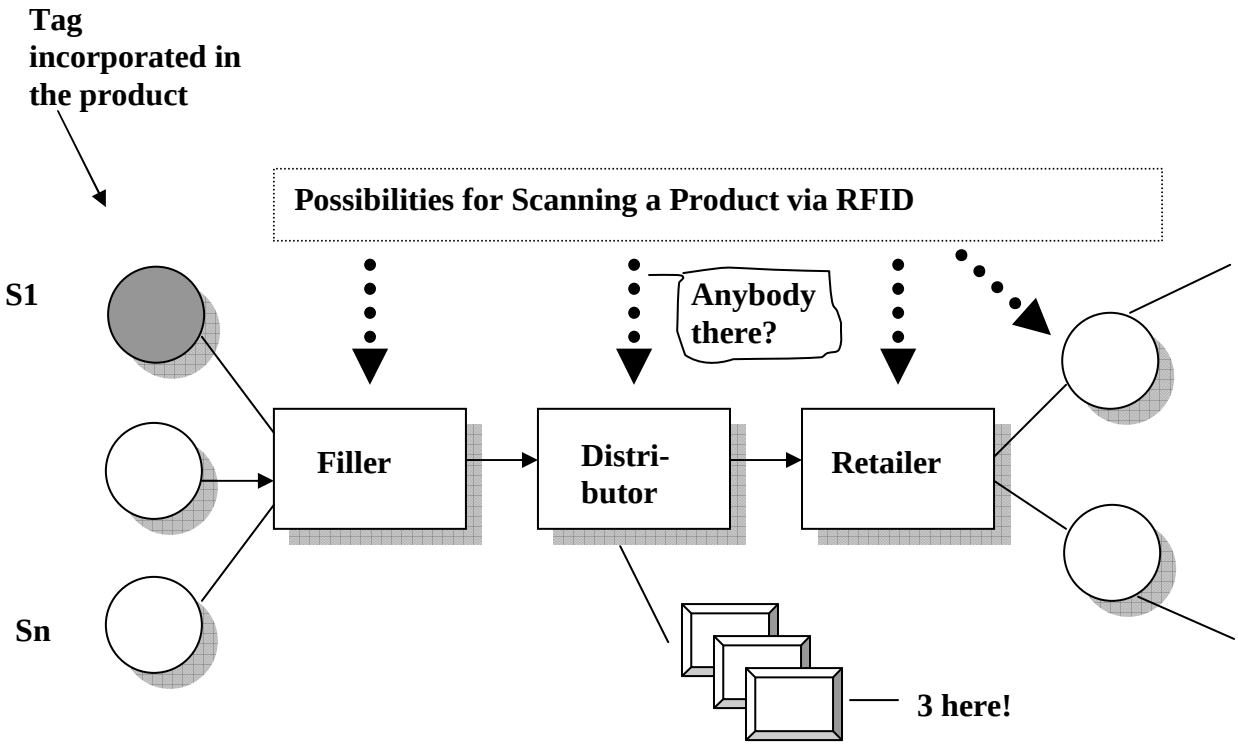

Figure 2: Supply Chain for a Consumer Product

the actual stock situation or any other required information at different stages in the supply chain. However, an important request is that the readers can identify and communicate with the different tags to reach the unique information from each tag. This requires standardised

global networks for identification of the EPC (Electronic Product Code) as a product flows from the supplier to a distributor and then to a retailer before it reaches the supermarket and the end customer (figure 2). EPCglobal Network is a vision coupled with an evolving set of standards that has the aim to provide a standard framework for product information exchange. As RFID tagged products moves through the supply chain, various actors need standard based means to share their tracking information on products based on the product tags.

Theoretical Points of Departure

Firms in industrial markets operate in a texture of available technology. On an aggregated level technical interdependencies are characterised by technological systems or 'paradigms'. The technological connection reflected in these paradigms and their evolution is a major force shaping the context of a firm and its relationships with third parties. "Business relationships can be seen as links that shape and reflect the existing technology" (Håkansson & Snehota 1995, p. 3). Analysis of implementing a new technology enhances therefore the relevance of the industrial network model. When the view of a firm as a production unit is applied it is the activity structure of the network that is most significant for analysis in relation to the effects of the technology.

A Supply Chain

Any firm's success in a business market depends to a great extent on its relationships with customers and suppliers. In most industries relationships are built up during considerable time. A relationship between different firms can be explained over a continuum from pure transactional relationships to collaborative relationships or partnerships (Ford et al.,1998). The working relationships are embedded in business networks comprised of connected relationships (Håkansson and Snehota, 1995). Working relationships and business networks are complex phenomena that also exist at multiple levels. A business network can be considered as a set of two or more connected business relationships. Connected in this sense means the extent to which exchange in one relation is contingent upon exchange (or non-exchange) in the other relation (Anderson et.al. 1994). Two connected relationships can also be directly or indirectly connected with other relationships as a part of a larger business network. A focal relationship can also be connected to several different relationships that either the supplier or customer has, where some are with the same third parties. A considerable amount of research has been devoted to explain relationships and business networks (Easton, 1992; Håkansson and Snehota, 1995). The business network can be analysed by using a model of three components – *actors, activities* and *resources* (Håkansson and Johansson, 1992). Actors are firms such as suppliers and customers that perform activities and control resources. Actors perform activities such as transactions and create value by transforming these resources in the mind of the customers. Resources can be of many kinds and refers to anything that actors explicitly value for their business processes. This means that resources can take many forms such as technology and technical know-how, equipment, personnel or capital for investments which a firm can use to generate greater value for itself or other stakeholders. In some situations a firm can possess a given resource for strategic purposes, but may instead look for other firms to develop the resource collaboratively. This can be in the form of a partnership or an alliance. Iansiti and Levien (2004) argue that strategy is becoming, to an increasing extent, the art of managing assets that one does not own (p.1). In a framework of the supply chain management literature Tan (2001) argues that in a truly 'integrated' supply chain, the final consumers pull the inventory through the value chain instead of the manufacturer pushing the items to the end users (p.40). Harland (1996) explain

supply chain structure as a dynamic interconnected supply network, whereas Hewitt (2000) describes a development stage beyond integrated business networks as demand chain communities. The focus of this paper is the evolving structure of the supply chain and how main actors are using the resources (e g new technology) for creation of competitive advantage. This is in line with Cooper et.al. (1997) how they describe the integration of business processes across the supply chain as a fundamental part of supply chain management.

Actors in a Supply Chain

In a packaging supply chain there are different actors involved at each added value level. In the first stage the producers are depending on different suppliers of raw materials. The reliance on external actors is depending on the grade of vertical integration in the following stages of the supply chain. This is highlighted when it comes to further converting or added value processes such as lamination or coating of different materials. The vertical integration can be both in the form of a technical or a commercial integration in the supply chain. In SCM research literature the traditional purchasing and logistic functions have evolved into a broader strategic approach to materials and distribution management known as supply chain management (Stank and Goldsby, 2000; Alvardo and Kotzab, 2001; Tan, 2001). Other research interests have covered global sourcing (Kotabe et al., 2003); management practise (Basnet et al., 2003; Bales et al., 2004) and integration within a supply chain (Cousineou et al., 2004)

Activities in a Supply Chain

From a theoretical point of view activities occur when one or several actors combine, develop exchange or create resources by utilising other resources (Håkansson and Johansson, 1992). These activities take the form of *transforming* and processing different resources by adding value at different stages in the supply chain. Another important element is also the *transfer* activities either to further processing or directly to customers. Single activities can be linked to each other in different ways. A main difference can be within industries with a high degree of vertical integration in comparison to competitive firms at a lower level of integration. Many activities are therefore tightly coupled to each others while others are more loosely coupled. However, a complete activity cycle is seldom controlled by a single actor.

Resources in a Supply Chain

The resources within a supply chain are controlled by the different actors. However, basic resources of strategic value are also controlled by single or jointly controlled by actors outside an industry. These resources are either in the form of raw materials or as supplies necessary for the production process in the form of products or services for the business. Resources are heterogeneous and have attributes in an unlimited number of dimensions (Håkansson and Johansson, 1992; Håkansson and Snehota, 1995). Some of the resources have also an alternative use either within other industries, or for further processing.

RFID - a new resource in the packaging concept

The main function that companies have granted to packaging has traditionally been related to the mission of protecting the products satisfactorily from producer to consumer. However, new customer needs has favoured consideration of new requirements on the design and development stage of packaging including logistic, commercial and environmental functions

(Dimitratos et.al.,2003; Hogg, 2003). The logistic function is defined by the way a product takes from the producer to the consumer and the packaging must fulfil the physical requirements within the supply chain. The commercial function concerns the needs from marketing communication, knowledge of customer demand and its potential impact on the purchase decision process. Numerous factors have made packaging to an important marketing tool. The environmental function relates to the re-utilization, recycling and reduction of packaging materials as well as the general ecological awareness. The function also includes the market environment with consumer, competition and legislative requirements. The RFID tag can be considered as function of the packaging concept and thereby considered for marketing purposes e g pricing purposes on the shelf in the store. Suppliers to global manufacturers need to consider the implementation of RFID tags into the packaging concept (Sörensen, 2006).

Actors in an Information Network with RFID

When a RFID tagged product flows from a manufacturer to a distributor and then to a retailer, an 'RFID network' can provide the actors with different kinds of information at each stage. The number of actors is depending on the actual product and its supply chain, where an RFID

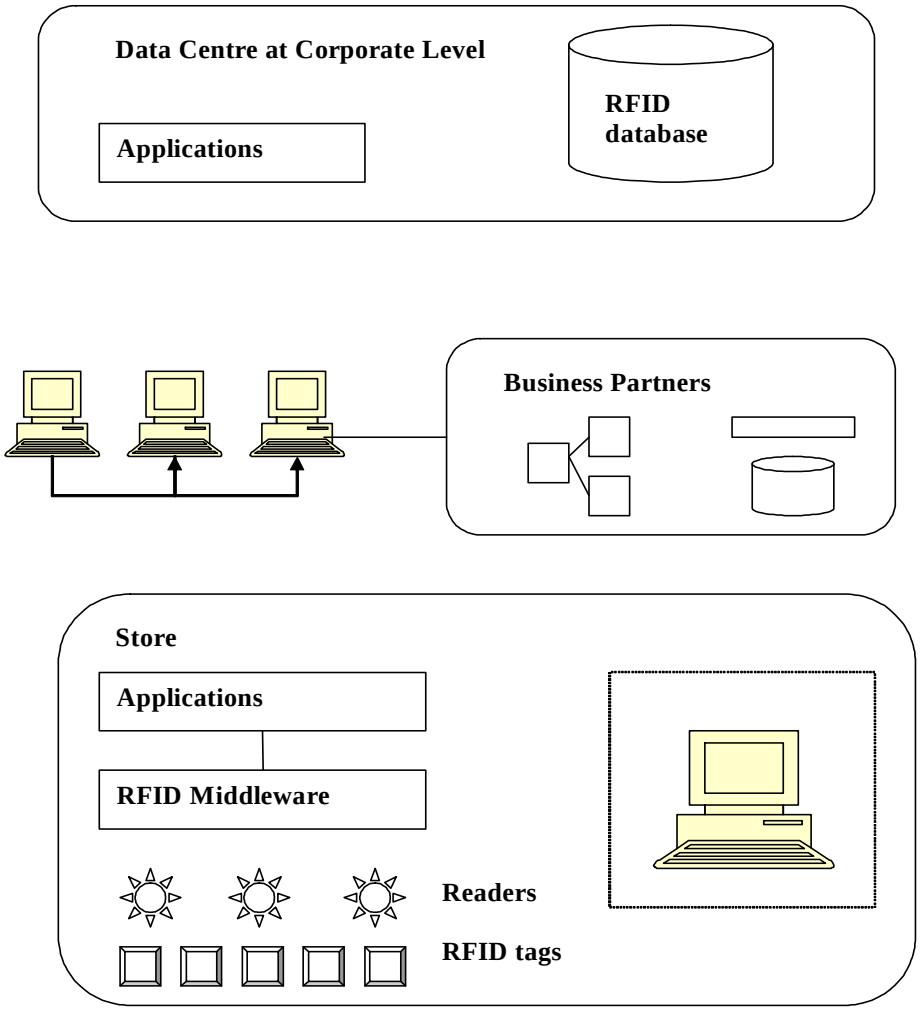

Figure 3: Actors in a RFID System

tag can be deployed either in the product, in the package or on the pallet. At its basic level a RFID system has different components at each stage. The tag (active or passive); a reader in a store or a warehouse; RFID middleware for applications and a data base for information service. *Another* actor can be business partners that will share information services and a *third actor* in the information network can be a data centre at a corporate level.

Resources in an Information Network with RFID

Every component in the information network with RFID is a resource for the total system.

Tags
An important resource in the RFID system is the tag which contains several important characteristics. One of them is the *packaging* since tags can be built into PVC buttons, paper labels or plastic cards among many other solutions. They can also be built into products and should be able to stand heat e g when painting in an auto assembly line. Another characteristic is *coupling* which refers to the communication between reader and tag. The choice of coupling affects the ability to communicate over a distance, the price of tags and conditions that might cause interference in the communication. RFID tags are either active or passive. In tags which are passive an electromagnetic field or a pulse of radio frequency energy emitted by the reader powers the tag. In active tags a battery powers the microchip, but active tags still need power from the reader for communication purposes. A third type of tags consists of tow-way tags which powers its own communication and can even be able to communicate with other tags without a reader. Other characteristics refer to the *information storage capacity* since tags have different amount of storage capacity. Many types of RFID systems also conform to particular national and *international standards* in order to work in different environments.

Readers
Readers are used to recognise available RFID tags and are comprised of different subsystems to capture RFID tag events. A reader transmits energy through one or more antennas and the tag pick up this energy and convert it to electrical energy via induction. The tag then sends the identity back to the reader in a code form. Readers have been developed for different uses and in many forms and sizes. They can be either stationary or portable for handheld activities.

Name	**Frequency range**	**Read range for passive tags**	**Application**
LW	30-300 kHz	50 centimetres	Pets; close reads of items with high water content
HF	3-30Mhz	3 meters	Building access control
UHF	300MHz-3 GHz	9 meters	Boxes and pallets
Microwave	> 3 GHz	> 10 meters	Vehicle identification

Figure 4: RFID Frequency Range

Middleware
Identifying tags is only a first step in managing a RFID system. The capacity to read and select information in big volumes when items move through a supply chain is another issue since tag codes can generate large volumes of data with complex interrelationships. One important benefit with using RFID middleware is that it can standardize ways of dealing with the amount of information that tags can produce. There are at least three primary advantages with using RFID middleware in the form of; providing connectivity with readers; processing raw RFID data and provide an application level interface to manage readers and capture filtered events.

Activities in an Information Network with RFID

The RFID network provides different activities or services for the actors using them. Among the activities the following can be separated (Glover and Bhatt, 2006):

Assigning unique identities
This is where the EPC comes in working as an identification system for the particular item. Tracking items would not be possible without the capacity to identify an item uniquely (such as manufacturer, product type, serial number).

Detecting and identifying items
The system for identification of items consists of EPC tags and readers, where each tag contains a microchip connected with an antenna. A tag is applied to an item either by the manufacturer or by an actor somewhere done the supply chain. The EPC readers use radio frequency waves to communicate with the tags. EPC readers then deliver information to local business information systems using some middleware.

Collecting and filtering events
EPC middleware provides suitable specifications for services that enable data exchange between EPC readers and business information systems.

Storing an querying events
The EPC information system enables actors and users to exchange data with business partners based on the actual EPC.

Locating EPC information
In order to enable business partners to share EPC data it is necessary to provide devices and services that can locate the storage for required data.

Discussion

Any new technology introduces both costs and benefits and RFID networks are no exception. RFID technologies offer practical benefits to anyone who needs to keep track of physical items either in the form of an animal, or products in a supply chain. One important benefit for manufacturers is the possibility to improve supply chain activities by increasing efficiency and demand planning. The introduction of a RFID system will inevitably affect the supply chain and its actors. The new technology will affect business relationships among actors which also are in line with Håkansson and Snehota (1995) findings.

The advantages of RFID systems versus barcode technology can be summarized by:

- No line of sight requirement
- The RFID tag can stand a harsh environment
- A relative long read range
- Portable database is possible
- Multiple tag read/write
- Tracking pets, products, luggage and equipment in real time.

Effects on actors

The introduction of a new technology has effects on actors in a supply chain in several ways. At a corporate level RFID technology gives opportunity for a firm to collect information that can be used for a better demand planning in a supply chain. It can also provide management with a more effective inventory planning and control. The information can furthermore be shared with business partners for reinforcing the relationships between the actors. Information can even be used for marketing purposes e g market segmentation or for pricing purposes in a store. Nike has even deployed RFID tags in sporting shoes which can be read via e g via an Ipod (RFIDnews, 2006b).

Effects on activities

UK based retailer Marks & Spencer continues to extend its successful RFID tagging at item level from 42 to 120 stores by spring 2007. Marks & Spencer has seen a sales increase by being able to have a close visibility of stock availability (Idtechex, 2007). The intention is to tag all its 350 million items of apparel yearly.

Effects on resources

RFID technology offers opportunities to new applications when it comes to trace and track products in a supply chain. Furthermore it opens up the possibility to develop 'smart products' within a supply chain, but even in relation to other market activities. The greatest number of tags supplied in 2006 was fore smart cards/payment key fobs and the second largest segment was for pallet and cases. The third area was for animals followed by smart tickets and secure documents (Swedberg, 2007).

The RFID technology offer possibilities for improving the efficiency in the supply chain by a more sophisticated inventory management giving opportunity to lower costs and improving results (Kearney, 2003). It can even offer better opportunities for improving security in relation to theft (e g for products like mobile phones) and counterfeiting which is important for the pharmaceutical industry. A more accurate demand analysis can even improve marketing efforts.

Conclusion

RFID technology including tags with characteristics of access to batches; possibilities for storage of mass data and capability to be reprogrammed have a clear advantage in comparison to barcodes. However, one of the main disadvantages is the cost for tags if applied to certain products especially within the consumer sector. Other technical concerns in RFID systems are referring to reliability (e g reading range) and interference from noise. High implementation costs are therefore impediment for the development of the technology in many supply chains.

The implementation of a RFID system have the possibility to create a competitive edge for a firm by introducing a better supply chain management efficiency by providing real-time visibility into what is in the stock or on the store shelves. RFID offer a technology where tags are unique and a product can be individually tracked as it moves between different actors in a supply chain. This gives management the opportunity to create ‘a supply chain visibility’ to every item in the supply chain. Using RFID-EPC will able a manager to count how much inventory there is on the shelf in a store and to use other unique information to a product e g expire date. The possibility to reduce inventory levels and inventory management expenses through implementation of RFID technology can save big amounts for actors in the supply chain. In contrast to barcodes RFID is not a line-of-sight technology and products can be traced without a person placing the tag in the direction of the reader. The RFID technology also permits products to communicate directly with inventory systems and can thereby reducing the need for labour and possibility of human error. The revenue can also be improved by greater visibility and fewer stock-outs. A better understanding of demand patterns can support promotional efforts. The cost of product losses (theft or supply chain leakages) can be reduced since the technology enables management to track merchandise movement. The adoption of RFID can obviously have an impact on business performance by increasing revenues, improving efficiencies and lowering costs for firms implementing the technology. A main contribution is also coming from pioneering RFID firms investing their research efforts into product development in order to decrease the costs of tags and sort out technical problems so that the RFID can be made available on a much larger scale.

Reference list

Alvardo, U, Y & Kotzab, H. (2001), ”Supply chain management”, **Industrial Marketing Management** (30), pp. 183-198.

Anderson, J, C & Håkansson, H & Johansson, J. (1994), ”Dyadic business relationships within a business network context”, **Journal of Marketing**, (58), October, pp. 1-15.

Aval, O. (2006), “EU e-passport project results”, **RFID.nordic.se,** September, p. 5-7, available at:www.rfidnordic.se/pdf/RFIDnr306en.pdf/ (accessed 6 March 2007).

Bales, R. R & Maull, R. S & Radnor, Z. (2004), “The development of supply chain management within the aerospace manufacturing sector”, **Supply Chain Management**, Vol. 9, No. 3, pp. 250-255.

Barney, J. (1991), “Firm resources and sustained competitive advantage”, **Journal of Management**, (17), pp. 99-120.

Basnet, C & Corner, J & Wisner, J & Tan, K. C. (2003), “Benchmarking supply chain management practice in New Zealand”, **Supply Chain Management Journal**, Vol. 8, No. 1, pp. 57-64.

Boström, P. (2006), “Intelligent logistics for smart tags”, **RFID.nordic.se,** November 2006, p. 7, available at:www.rfid.nordic.se/pdf/RFIDnr406EN.pdf (accessed 6 March 2007).

Capgemini. (2005), “Consumer education is key to boosting awareness and overcoming misconceptions about RFID”, available at:www.capgemini.com/resources/news (accessed 10 January 2007).

Christopher, M. (1998), **Logistics and Supply Chain Management. Strategies for Reducing Cost and Improving Service,** Prentice Hall, London.

Cooper, M. C & Lambert, D. M & Pagh, J. D. (1997), “Supply chain management more than a name for logistics”, **The International Journal of Logistics Management**, Vol. 8, No. 1, pp. 1-13.

Cousineou, M & Lauer, T. W & Peacock, E. (2004), “Supplier source integration in a large manufacturing company”, **Supply Chain Management Journal**, Vol. 9, No. 1, pp. 110-117.

Dimitratos, P & McDonald, F & Tűsselmann, H (2003), “International economic and environmental changes” in Hart, S (Ed.) **Marketing Changes**, Thomson, London, pp. 9-28.

Easton, G. (1992), “Industrial networks: a review” in Axelsson, B & Easton, G (Ed) **Industrial Networks: A Review of Reality**, Routledge, London, pp. 1-27.

Ford, D et. al. (1998), **Managing Business Relationships**, Wiley & Sons Ltd, Chichester.

Glover, B & Bhatt, H. (2006), **RFID Essentials,** O’Reilly Media, Sebastopol.

Harland, C. M. (1996), "Supply chain management relationships, chain and networks", **British Journal of Management**, Vol. 7, March, pp. S63-80.

Harland, C, M & Lamming, R, C & Cousins, P. D. (1999), "Developing the concept of supply strategy", **International Journal of Operations and Production Management**, Vol. 19, No. 7, pp. 650-673.

Hewitt, F. (2000), "Demand satisfaction communities: new operational relationships in the information age", **The International Journal of Logistics Management,** Vol. 11, No. 2 , pp. 9-20.

Hogg, G. (2003), "Consumer changes", in Hart, S (Ed.) **Marketing Changes**, Thomson, London, pp. 29-46.

Håkansson, H & Johansson, J (1992), "A model of industrial networks in Axelsson, B & Easton, G (Ed.),**Industrial Networks: A Review of Reality**, Routledge, London, pp. 28-34.

Håkansson, H & Snehota, I. (1995), **Developing Relationships in Business Networks** (Ed.), International Thomson Business Press, London.

Iansiti, M & Levien, R. (2004), **the Keystone Advantage. What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation and Sustainability,** Harvard Business School Press, Boston.

Idtechex. (2007), "RFID Forecasts, Players & Opportunities 2007-2017" (a summary) available at www.idtechex.com/forecasts (accessed 23 March 2007).

Kearney, A. T. (2003), "RFID will bring great benefits for retailers", available at: www.retailindustry.about.com/cs/it/_rfid/a/bl_atk111003.htm (accessed 23 March 2007).

Kotabe, M & Murray, J, M. (2003), "Global sourcing strategy and sustainable competitive advantage", **Industrial Marketing Management**, (33), pp. 7-14.

Morgan, R. E & Strong, C. A. (2003), "Business performance and dimensions of strategic orientation", **Journal of Business Research**, Vol. 56, pp. 163-176.

Meredith, S. (2006), "Identifying the business benefits of RFID", VNU Network available at:www.vnunet.com/2165344 (accessed 26 March 2006).

Oldeén, P. (2006), "Asiana airlines and asian idt bagagetagging", **RFIDnordic.se,** May, p. 4, available at:www.rfidnordic.se/RFID_nr2_06ENG.pdf (accessed 6 March).

Peteraf, M. (1993), "The cornerstones of competitive advantage: a resource-based view", **Strategic Management Journal**, Vol. 14, No. 3, pp. 179-191.

Porter, M. E. (1990), **Competitive Advantage. Creating and Sustaining Superior Performance**, the Free Press, New York.

Porter, M. E. (1996), "What is strategy?" **Harvard Business Review**, November-December, Vol. 96, No. 6, pp. 61-78.

Rehn, M. (2006), “Advanced RFID solution increases the security level and makes parking more efficient at Stockholm airport”, **RFIDnordic.se,** May, p. 3, available at:www.rfidnordic.se/RFID_nr2_06ENG.pdf (accessed 6 March).

RFIDnews. (2007a) available at: www.rfidnews.se (accessed 10 January 2007).

RFIDnews. (2007b), “Nike”, available at www.rfidnews.se (accessed 11 January 2007).

Sandberg, A. (2006), “The gentle tag: putting RFID into a technology and society context”, **RFID.nordic.se,** November, p. 11-12, available at:www.rfidnordic.se/pdf/RFIDnr406EN.pdf (accessed at 6 March 2007).

Sheffi, Y. (2004), “RFID and the innovation cycle”, **The International Journal of Logistics Management,** Vol. 15, No. 1, pp. 1-10.

Slater, S, F. (1996), “The challenge of sustaining competitive advantage”, **Industrial Marketing Management**, (25), pp.79-86.

Stank, T, P & Goldsby, T, J, (2000), “A framework for transportation decision making in an integrated supply chain”, **Supply Chain Management**, Vol. 5, No. 2, pp. 71-77.

Swedberg, C. (2007), “Smart card and retail supply chain applications expected to drive RFID growth”, **RFID Journal,** available at www.rfidjournal.com/article/articleprint/3149/-1/1 (accessed 23 March 2007)

Sörensen, J-C. (2006), “Är du leverantör till en multinationell tillverkare – räkna med att du måste RFID tagga”, Seminar at Scanpack 2006. Danish Technolgical Institute.

Tan, K, C. (2001), “A Framework of supply chain management literature”, **European Journal of Purchasing & Supply Management**, (7), pp. 39-48.

Tutorial-Reports.Com. (2007), “Wal-Mart and RFID: a case study, available at www.tutorial-reports.com (accessed 26 March 2007).

Yu, S-C. (2007), “RFID implementation and benefits in libraries”, **The Electronic Library**, Vol. 25, No. 1, pp. 54-64.