A STRATEGIC ASSESSMENT OF THE CHALLENGES INVOLVED IN ENTERING THE CARGO CONTAINERS TRACKING AND SECURITY MARKET FOR AN RFID COMPANY

by

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Abstract

A strategic analysis is performed of how eXI Wireless Incorporated (eXI), a relatively mature company, can best address an opportunity for applying Radio Frequency Identification (RFID) technology to the tracking and security of cargo containers. eXI has identified this opportunity because of its size and growth potential. The RFID industry, Containers market, resources and competencies of eXI are analyzed in detail. Findings suggest that eXI will be highly challenged to succeed in this marketplace given that it is driven by large, highly experienced and influential players that are consolidating and attempting to standardize the market. Specifically, the key capabilities of eXI are technology-based and are not expected to provide competitive advantage in a new market where standards and consolidation override the value of the technology itself. eXI is therefore advised to focus on managing its competences to leverage the firm into markets in which it can more easily create value.

Dedication

To my parents Aziz and Begum, your encouragement and unconditional support is the source of my inspiration. In addition, to my sister Naila and her family, and to my girlfriend Sherina, I thank you for helping me succeed by giving me your patience and continual encouragement to work hard for all those long nights and weekends. Finally, to my late uncle Amir, your legacy of hard work, dedication, and compassion, is a source of motivation in all that I do.

Acknowledgements

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1 Introduction

eXI Wireless Inc. (eXI) develops and markets wireless identification, control, and location technologies to assist with the tracking of individuals and assets. These tracking systems combine radio frequency identification (RFID) and real-time location system technologies (RTLS) into state-of-the-art, unobtrusive solutions. Located in Richmond, a suburb of Vancouver (British Columbia) on the west coast of Canada, eXI has over 200 distributors worldwide. Publicly traded on the TSX venture exchange, eXI has experienced over 10 consecutive quarters of profitability and has a stable financial foundation. eXI has twice been a member of Business in Vancouver's list of the top 50 fastest growing companies and is generally recognized as a top technology company.

1.1 Products and Markets

eXI acquired its technology over two decades ago and has since been developing and marketing RFID and RTLS technologies and has successfully deployed these systems for applications within some of the earliest adopter markets. These markets include the Healthcare and Industrial sectors.

The vertical market within the Healthcare sector includes healthcare facilities such as hospitals and medical centres. One application of eXI wireless products within the Healthcare sector provides solutions for abduction protection for infants (the HALO Infant Protection System) and off-premise patient wandering protection (the RoamAlert Wander Protection System). A second application is a management system for tracking mobile assets and locating specialized medical equipment (Assetrac Location & Protection System).

The vertical markets within the Industrial sector include the Construction, Oil & Gas, and Power Generation industries. The application of eXI wireless products within these sectors primarily relates to the tracking of industrial mobile assets. For this application, eXI management systems such as Tool Hound SC, HOUNDware Onsite, and HOUNDware Online are available.

Within recent months, eXI has leveraged its knowledge and experience to provide RFID and RTLS-based original equipment manufacturer (OEM) solutions. These are developed for vendors looking specifically to improve their product offering with RFID technology. eXI develops the components for the vendor's product/service infrastructure and implements the solution through integration services. The overall success of eXI's products and technological infrastructure in existing and OEM markets demonstrates the potential for commercialisation of the technology within new markets.

1.2 Technology

At the core of the wireless solutions developed at eXI is a short-range wireless platform consisting of reliable and scalable hardware components. These components consist of active RFID tags[1], wireless receivers, access points, controllers, and scanners connected through network protocols and management software. This infrastructure allows building premises and areas up to 200 feet to be covered to protect, track, and locate individuals and assets; furthermore, this infrastructure serves as a basis for custom OEM products. Applications can then run on top of this infrastructure to complete the customer solution.

eXI has been a leader in the development of RFID technology and currently holds 3 patents. The active RFID tags are the smallest in the world, and the longest lasting with a 4-year battery life. Furthermore, these tags utilize a unique, patented skin-sensing technology. For

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[1] Active RFID tags are battery powered, capable of transmitting information, and often encompass read/write functionality. Passive RFID tags do not require a battery, are incapable of transmitting data beyond two or three inches, and can also contain read/write functionality. To read tag data, scanners and readers need to be in closer proximity to passive tags.

mobile assets, eXI developed the first web-based enterprise-wide management system, pioneered the development of wireless real-time data collection, and was the first to develop a hybrid reader for both RFID chips and bar codes. eXI solutions can readily integrate third-party technologies such as bar codes and smart cards and are scalable from simple door and ward control to multi-floor and multi-building protection.

1.3 Strategy

eXI's existing market strategy is premised on the lack of standardization of active RFID technology which has created silos of industries with their own standards. This has made it difficult to expand beyond niche market expertise and existing customer segments. eXI has adopted two key strategies to work within this issue: lead current markets and pursue international expansion.

In order to expand into new vertical markets, eXI may be required to penetrate "silos of standardization". The company could accomplish this through strategic partnering with companies that have developed solutions for these markets. Since the same or similar technology can be deployed across a number of markets, successful market penetration would require eXI to strategically leverage its technology, products, and expertise to overcome impediments posed by standards within potential markets. eXI is currently looking to expand its product/service offering beyond its existing segments by looking toward potential expansion into the tracking and security applications for the Containers market.

1.4 Aim and Scope of Analysis

The aim of this paper is to analyze the overall RFID environment and internal competencies of eXI in order to determine how the company can enter the Containers tracking market. By evaluating the Containers market and the external environment, the factors affecting

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this market opportunity can be assessed. Analyzing internal competencies determines the extent to which the company is able to address this identified market. The degree of strategic fit of the company to the market opportunity can then be determined so alternative implementation plans can be developed and go-to-market options recommended.

eXI is currently undergoing acquisition by Applied Digital Solutions (ADS) scheduled for completion in April 2005. While subsequent analyses in this paper consider the potential effects and synergies on market development opportunities and internal competences, the ramifications of these are not analyzed in detail given the limited access to ADS at this time. Hence, while the competences and strategies at eXI may alter once it has been acquired, the potential effects of this with respect to the scope of this paper are considered where applicable, but not analyzed in detail.

Although this acquisition has not been finalized, the assumption is that it will be completed. Furthermore, in accordance with information sources at eXI, it is assumed that eXI will not only be merged with another ADS company, Verichip, but will also take on the Verichip name and be known as an "RFID for People" company. Verichip has developed the first and only implantable passive RFID tag. While potential changes in competences and management due to the integration of eXI and Verichip are acknowledged where applicable, these are not discussed in detail due to the limitations of available information.

Research efforts for this paper are not focused toward existing markets of eXI. Furthermore, emphasis is toward potential opportunities in the Containers market that eXI can address by leveraging and deepening its existing knowledge and competences. This is based on the assumption that eXI is looking to leverage, build on, or modify its existing technological infrastructure and competence and resource base, as opposed to developing or implementing core technological infrastructures and capabilities that are completely new to the firm. The Containers

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market is emerging quickly and has already been identified as having strong market potential and is of particular interest to eXI; so emphasis is placed on researching this particular market. Research and assessment of competences and resources is within the context of evaluating what would be required for eXI to successfully compete in the Containers market. In this regard, research and analyses discuss what will be required of eXI to enter this market, as opposed to what would be required of eXI to successfully compete in existing or alternative markets. Hence, the context of this paper is to determine the extent to which eXI can successfully enter and compete within the Containers market based on internal and external resources that are currently available to the firm.

eXI has expressed interest in playing a role in the development of standards within the Containers market, so this consideration is taken into account. The extent to which this can be accomplished will be largely determined by competences arising from combining the firm's internal and external resources.

Chapter 2 looks at the external RFID environment of eXI to determine the context within which the company is operating and within which the Containers market is developing. Having established the environmental context, the analysis ends with an overview of eXI's existing markets. The following chapter then analyzes the Containers market. A deeper understanding of internal competences and resources at eXI is obtained in Chapter 4. Chapter 5 combines the findings of the previous three chapters to discuss potential options regarding how the firm can create value in the Containers market. Chapter 6 discusses the recommended implementation and corresponding challenges and risks, and is followed by concluding remarks in Chapter 7.

2 The RFID Industry

This chapter serves to set the context of the industry within which eXI is currently operating. It is within this environment that eXI will strategically leverage its technologies and resources into future markets, so an understanding of the environmental factors to be considered is required. The background of the RFID industry is presented followed by an overview of the technology and how it can be expected to affect the business processes of the value chain giving rise to the blurring of boundaries and increased visibility among industries. Emerging trends and existing forces affecting the delineation of these boundaries are then discussed followed by an overview of existing RFID markets. The chapter concludes with a discussion of markets in which eXI currently participates.

2.1 Background

Although the beginnings of RFID technology date back to 1948, it was not until 1984 that RFID reached the commercialization stage in the very early adopter markets relating to tagging livestock and tracking railroad cars and fleet vehicles (Dlouhy Merchant Group, 2004, p. 6). RFID technology then continued evolving toward new applications requiring improved performance, sizing, and reduced costs such as toll collection, animal tracking, and personal identification. During the 1990s, large semiconductor companies such as Texas Instruments, Motorola, and Philips Semiconductor became involved with design and development of RFID technology and further contributed to its reduced form factors and extended applications (Kimball, 2004, p. 3). The involvement of these and other firms in continued development efforts resulted in the marketplace entry of a significant number of RFID technology developers and equipment providers for new and extended applications.

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This influx of a vast number of RFID technology providers resulted in a significantly increased number of potential markets and led to the eventual formation of the Auto-ID Centre in 1999 at the Massachusetts Institute of Technology involving several universities and other organizations. The objective of this foundation is to develop open standard architectures for the implementations of RFID systems and technologies.

2.2 Technology

The implementation of RFID systems requires an antenna, a transceiver, and a transponder or tag. The antenna and transceiver are frequently put together to form a reader. The reader emits radio waves throughout its transmission area and is often connected to a controller such as a computer or information processing system. There are two kinds of tags: active and passive. Active tags contain a battery, microchip, and an antenna; passive tags do not contain a battery. Passive tags harness the power radiated from the readers signal to transmit data; active tags use battery power to transmit data and can subsequently transmit over larger distances under a variety of environmental conditions.

When radio waves are detected by the tag, it sends data back to the reader. The data from the reader is transmitted to the host or network controller for processing before being passed on to a central server which handles network communications, business logic, database serving, and application serving. The data received from the reader contains tag identification and other information and causes some action to be taken such as the updating of a database, the locking of a door, or triggering of an alarm. One or more computers can be connected to the server to monitor the data and update system parameters. Depending on the complexity of the tag design, information about an action or event can be transmitted from the reader and written back to the tag. Tags and readers must be tuned to the same frequency in order to communicate properly.

The type of RFID application determines the type of system required. For example, passive tags, which have shorter transmission distances and are cheaper than active tags, are typically suited for read only applications such as those for the retail industry. Active tags, which are the kind developed at eXI, are appropriate for tracking assets over greater ranges through challenging and harsh environments such as inside large buildings, warehouses, and industrial settings.

2.3 Blurring Boundaries by Adding Business Value

Current RFID applications impact business processes and add value by decreasing costs, increasing efficiencies and adding value in the following ways (Herrmann, 2004, p. 7):

1. Managing inventory ranging from the raw materials to finished goods giving rise to reductions in shipping/receiving errors, stock-outs, losses, and related issues;
2. Monitoring components during manufacturing resulting in improvements relating to operational efficiency, bottlenecks, and assembly processes;
3. Protecting valuable assets yielding reductions in counterfeiting, theft, and unauthorized transport;
4. Assisting with identification of personnel and authorization giving rise to improved access control and scheduling of locations;
5. Analyzing of automatically generated data contributing to improvements in business process efficiency, asset utilization, maintenance forecasting, and equipment scheduling.

The net effect of these impacts combined with continual evolution of RFID technology is that the ways in which RFID interacts with businesses are continually expanding. This continuous evolution enables the development of new business models as discussed later in this chapter in section 2.4.4.

RFID is an enabling technology that allows a given organization or market segment to improve efficiencies relating to business processes. More specifically, RFID adds value to the firm by allowing business practices to be enabled and monitored by information communication technologies such as the internet and intranet. As a result, data can now be collected within the

firm and throughout its value chain during the implementation and monitoring of RFID-enabled

business processes. The codification of this previously unavailable data allows for analysis and

portability of data to the extent that different operational departments within the same

organization can have visibility or "windows" into the operations and efficiencies of other

departments and the organization overall. The same rationale applies to the various operational

segments with a given value chain. This means that the application of RFID within a given

industry is an enabler of the blurring of boundaries between the traditional operating segments.

Hence, RFID is able to not only span industry boundaries through application to many

different markets, but also blur boundaries between operational segments within a given market

or industry. Given such a large scope and constant technological evolution, it is difficult to define

boundaries for the RFID industry and the applications of the technology. In light of these unclear

boundaries, the RFID industry can be seen in terms of how present trends and forces act upon it

to not only develop and shape new markets, but also consolidate existing markets. Trends are

discussed in the next section in the context of being key enablers to further the adoption of RFID

technology and promote further applications. Forces are then discussed in the context of how

they are likely to challenge the continued uptake and development of RFID applications.

2.4   Trends – Potential Influences for RFID

Certain trends have been identified as having significant potential impact in the near

future for the RFID industry (Bhuptani & Moradpour, 2005, pp. 2-13). The following section

discusses these developments pertaining to the areas of RFID tags, information processing,

advanced readers, business processes and intelligence, standards and legislation. Such potential

advancements in RFID can simplify, extend, and further promote the use of existing functionality

by way of increased number of applications, reduced costs of implementation, increased data

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processing efficiency, improved decision-making ability, and standardized RFID communication protocols.

2.4.1 Developments in RFID Tag Technologies

Within the past several months, progress has been made in the development of RFID tag technologies. Advancements have been made in the areas of chip-less tags, flexible tags, printed electronics, and sensory tags (Bhuptani & Moradpour, 2005, pp. 2-4).

Significant developments have evolved in the area of chip-less tags. Such devices surpass the limitations of existing active tags with respect to signal transmission and interference. These technologies overcome existing limitations due to the presence of metal, liquid, high temperature, and low humidity near the active tag. In addition, chip-less tag technology offers the potential of reduced tag manufacturing and development costs due to the absence integrated circuits. Furthermore, power consumption requirements would be less due to the reduction in circuitry. As a result, existing limitations on size and type of battery and tag would be alleviated. This is accomplished through use of advanced technologies such as Surface Acoustic Wave, Nanotechnology, and Genomics. Several firms are actively participating in the development of advanced active tag technologies including CrossID, Inkode, Pharmaseq, RF SAW, and Tapemark.

A significant advancement has been made in the area of flexible active tags. With tag packaging similar to flexible passive tags, such as label tags, a semi-active tag has been developed with a thin, flexible batter for a power source. Flexible tag technology gives rise to host of potential RFID applications relating to irregular surface texture such as adhesive tagging. This technology is developed by Smart Active Label Technologies.

Another significant development impacting tag design relates to the field of printed electronics. This involves printing antennas and other potential components using conductive ink. Such an application gives potential for inexpensive tag development utilizing conductive ink as a replacement for various electronic components thereby reducing overall tag size and costs and enabling customization of tag shape and size. With savings in size, costs, product development, and manufacturing requirements, and improvements in customization potential, such a technology could be disruptive to existing RFID technologies and applications. Precisia has already started manufacturing a smart label RFID tag using conductive ink.

Sensory tags combine tag functionality with sensors thereby allowing the tag to monitor, record, and transmit different types of environmental information in addition to pre-programmed data. Developments are expected with respect to implementation of sensory tags in very small form factors. Such devices would open up a range of RFID applications such as facial movement monitoring to allow handicapped individuals to control wheelchairs and other devices. Companies such as Dust Networks are working on the miniaturization of such technology down to the size of one cubic millimetre.

The implementation of the above technologies combined with ongoing advances in production techniques can be expected to drive the price lower for RFID tags. Furthermore, pricing will continue to drop as tags are manufactured in higher volumes to meet the expected increases in demand. Widespread adoption of RFID technology is expected around the US$0.05 target price for passive tags, although this is not predicted to occur for the next several years (Ward, 2004, para. 1). Given that today's cheapest tag prices hardly drop lower than US$0.25 (Bhuptani & Moradpour, 2005, p. 6), it is expected that the combined effect of improved tag design and more efficient tag manufacturing will be required to further reduce tag prices.

2.4.2 Information Processing

As RFID systems generate increased amounts of data, increased computational power will be required in order to process the information at or near real-time (Bhuptani & Moradpour, 2005, pp. 4-5). As the number of RFID tags and transactions increases for a given computer network, traditional computing hardware will be unable to process or handle the data.

A number of large computer companies are developing a new microprocessor architecture called Chip Multi-Threading (CMT). Sun Microsystems has already introduced the first generation of this new architecture. Unlike traditional microprocessor designs, CMT technology is developed to enable to the performance of many tasks simultaneously, as opposed to performing single tasks faster and faster. This new generation of microprocessors would allow for RFID systems to handle information from many tags simultaneously thereby giving rise to improved processing efficiencies and scalability of the number of allowable tags. Hence, although existing processing power does not limit ongoing developments in RFID applications and technology, the limitations of existing processors will constrain the amount of information which can be expediently processed in an RFID system as it grows in complexity.

Peer-to-peer computing can also be utilized to alleviate the burden of centralized information processing (Bhuptani & Moradpour, 2005, p. 6). This suggests that the RFID readers could perform some of the processing before passing the data on to centralized computing resources. Therefore, RFID readers are expected to become increasing more intelligent. In light of the increased volumes and extended applications of RFID data expected, RFID readers will inevitably be required to perform much of that which is accomplished by computer processing today.

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2.4.3 Agile Readers

A trend is evolving toward using readers with increased levels of intelligence and processing capability. Such devices can work with more than one brand of tag and are designed with powerful microprocessors that offer advanced processing capabilities, additional operating systems interfaces, and greater programmability options (Dlouhy Merchant Group, 2004, p. 13). Hence, the movement has already begun toward the development of more intelligent or "agile" readers.

Given the significant costs of readers over tags in light of the additional processing capabilities required, upgrade functionality would be desirable to reduce the number of reader replacements and modifications. Hence reader architectures to support current, future, and multiple tag protocols would be required. Combining such options with features such as adjustable power outputs would allow for agile readers to be utilized across regions throughout the world by allowing the device to comply with localized regulatory requirements for wireless data communications. In addition, developments regarding directional RFID antennas are expected to further assist in contributing to regulatory compliance, reduced reader errors, and improved range of coverage (Dlouhy Merchant Group, 2004, p. 13). While existing reader functionality is not expected to hinder continued development of RFID technologies and markets, increased reader agility will result in improved processing power and robustness for RFID systems.

2.4.4 Business Processes and Intelligence

From a high level, successful implementation of RFID provides an organization with competitive advantage, reduced costs, and increased revenues. This has resulted in revamping of existing business models and processes in order to maximize the return on investment of the RFID implementation. The real business potential for RFID is only in its beginnings according to

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research on existing RFID deployments (Bhuptani & Moradpour, 2005, p. 7). Such research claims that much of the potential business benefits from RFID implementation will be driven by efforts from large institutions such as Wal-Mart and the United States Department of Defence (DOD) that are currently spear-heading large scale implementations of RFID with their respective supply chains. Given the expected economies of scale in these implementations of RFID technologies, these mandates are expected to impact all RFID markets by way of ripple effects originating from supply chain implementations. As an illustration of the expected growth, the VDC expects revenues from global shipments of RFID systems to reach US$4.0 billion by 2007 – up from an estimated US$1.25 billion in 2004 (Bhuptani & Moradpour, 2005, pp. 7).

Significant revamping of business processes is expected to ensue as item-level asset tagging technologies become cheaper and more viable (Bhuptani & Moradpour, 2005, pp. 7-9). The resultant economies of scale can be expected to promote widespread adoption of tagging technologies and implementations throughout all industries engaged in monitoring assets. The recent supply-chain mandates by larger institutions can be expected to produce continuous streams of new RFID applications of asset management. This will lead to increased business intelligence with respect to decision making, overall competitiveness, and efficiency of operations. Many firms may not be able to handle the implementation of large scale RFID implementations by themselves. This will create opportunities in the area of outsourcing of management services.

The revamping of business processes will also extend to the extent that business-to-business transactions will be able to share information more effectively (Bhuptani & Moradpour, 2005, pp. 9-10) – as this is a primary goal of implementing RFID within the supply chain. This takes the outsourcing opportunity from RFID implementation to RFID systems integration thereby creating a requirement for expertise in this area. The recent mandates by businesses such

as Wal-Mart and DOD will serve as extremely powerful catalysts for the development of technologies and methodologies to achieve success in these areas.

2.4.5 Standards and Legislation

The International Standards Organization (ISO) has taken efforts to develop some industry-standards for RFID over the last 20 years and continues to do so (Bhuptani & Moradpour, 2005, p. 10). For various RFID applications, standards are evolving regarding the use of particular technologies; in some cases, these standards can be country specific (Dlouhy Merchant Group, 2004, pp. 14-16). Despite the trend toward development of standards, the evolutionary process for developing standards, regulations, and mandates is slow and entails ongoing debates and exchange. Although government subsidies within some industries can be expected in order to jump-start the adoption and standardization of RFID technologies for particular applications, the potential benefits from RFID implementations may well be immediate enough to warrant large investments for many organizations before the subsidies occur. Such circumstances may give rise to competing RFID technologies and solutions for given applications thereby further challenging the standardization efforts.

2.4.6 Consolidation of RFID Vendors and Products

The RFID industry has experienced increased consolidation among its vendors over the recent months. This consolidation has occurred by way of acquisitions and partnership arrangements. Vendors are teaming up to offer integrated packages as RFID solutions. Examples of these partnerships are as follows:

1. On September 9, 2004, Symbol Technologies, the world's largest provider of portable data terminals and bar code scanners, acquired Matrics, a manufacturer of RFID readers and tags based on Electronic Product Code (EPC) standards (Dlouhy Merchant Group, 2004, p. 29);
2. Announced on September 27, 2004 (Malykhina, 2004, para. 1), Hewlett-Packard teamed up with OATSystems Inc., a middleware provider, and BearingPoint Inc., a business consulting and system integration firm, to launch RFID platforms;

3. Announced on October 26, 2004 (RFID Gazette, 2004, Sun Microsystems section, para. 3), Sun Microsystems teamed up with SeeBeyond to work on one of several RFID solutions for vertical and horizontal markets;

4. Announced on January 27, 2004 (Collins, 2004, January 27, para. 1), IBM and Philips intend to partner together to deploy RFID systems for retailers and manufacturers;

5. Announced on August 16, 2004 (Sullivan, 2004, para. 1), Sybase is teaming up with AeroScout to develop an early adopter RFID tracking application.

The net effect of consolidation among the RFID vendors is that industry structure is reshaping and taking new form. As a result, the dynamics and competitive advantages of the previous paradigm could shift significantly. This will inevitably lead to new forms of power struggles among the major partnerships that result from consolidation. The overall impact of this would be that power, influence, and standardized offerings by the new paradigm of vendors will end up becoming more important than the technology itself. This means that smaller firms with less power to influence the technology adopters will not prevail in this environment regardless of how well their technology offerings perform unless they also consolidate their technologies to provide expanded and standardized solutions.

Given this shifting of the dynamics within the industry, it is important for smaller firms like eXI to capture the value of their technologies in the marketplace today – while there is still opportunity. In addition, in order for eXI to maintain or increase influence within existing and future markets, consolidation will inevitably become an enabling requirement to accomplish this successfully. Hence, although eXI has undergone consolidation by leveraging itself in terms of partnerships and resources (discussed in section 4.3), such efforts will be required on an ongoing basis in order for the firm to compete successfully within an increasingly consolidated RFID environment.

2.4.7 Overall Impact of Trends

The trends discussed above are expected to drive the ubiquitous adoption of RFID technologies and thereby promote the growth of new and existing applications. Such advancements can achieve the following effects on RFID systems: make existing applications easier to use, increase functionality, and decrease costs of deployment and implementation. Combined with the ongoing consolidation of RFID vendors, these effects can be expected to lead to new applications for RFID technology. Hence, these trends are likely to result in the development of a larger and more complex market for RFID technologies. However, the timing of these outcomes is difficult to predict, as is the degree to which these trends might interact to create further applications. Nevertheless, these emerging trends are subject to current forces that are challenging the adoption of RFID technologies, systems, and applications.

2.5 Forces – Immediate Factors Affecting Implementation of RFID

The variety of RFID applications has resulted in the development of a number of different platforms and implementations. This section discusses important challenges concerning the development of common data transmission frequencies and standards in additional to hurdles relating to tag prices, deployment challenges, and privacy issues. These factors are currently viewed as barriers-to-adoption of RFID technologies. Overcoming these barriers will promote wider-spread adoption giving rise to common platforms for RFID systems and applications thereby promoting the economies of scale required to support mainstream adoption.

2.5.1 Transmission frequencies

Transmission frequency conflicts arise regarding international use of the ultra high frequency band (UHF). The Federal Communications Commission has made the 902MHz to 928MHz bands available for RFID applications in North America (Dlouhy Merchant Group, 2004, p. 15). The UHF range of transmission frequencies also allows for long range reading for

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reader distances greater than one metre from the tag. Meanwhile, in Europe the transmission frequency range assigned is only 865MHz to 868MHz (Dlouhy Merchant Group, 2004, p. 15). Furthermore, transmission power for tags in North America is limited at 4 watts in comparison to only 0.5 watt in Europe. China is still undecided about spectrum allocation for RFID applications, but may come to a decision sometime this year (China Economic Net, 2005, para. 1). The UHF bands assigned in North America and Europe conflict in China where these frequencies are used for mobile communications and radio channels.

These regional differences in transmission frequencies and powers translate to RFID system design considerations relating to minimum required distances between tags and receivers, and locations of antennas. As a result, economies of scale in system design, manufacturing, and system deployment are compromised thereby limiting adoption rates of RFID systems. While these factors would not hinder deployments at the regional level, differences in these frequency spectrums presents a formidable barrier to implementation for international RFID supply chain tracking initiatives by institutions such as the DOD and Wal-Mart. Such barriers could dramatically impact the entire RFID industry as discussed in further detail in section 2.6.

Even though agile readers may be able to adapt to the regional transmission and radiated power differences, the overall RFID system design at the deployment level may vary given the limited transmission power of only 0.5 Watt at the low end combined with environmental factors such as the presence of metals, liquids, etc. Furthermore, agile readers would require advanced design complexity resulting in increased costs of hardware, manufacturing, testing, and implementation.

2.5.2 Standards

Another barrier to adoption has been the lack of definitive communication standards between readers and tags (Dlouhy Merchant Group, 2004, p. 16). This barrier translates to a lack

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of interoperable hardware among RFID vendors and constrains economies of scale at the production level.

The ISO is currently working with major RFID hardware manufacturers to develop open-air interface communication standards (ISO-18000) primarily aimed at supply chain applications that are expected to form the industry platform for RFID applications, standards, and overall market growth. These standards will need to be developed soon to allow for fulfilment of the RFID deployment mandates of Wal-Mart and the DOD at the international level.

EPCglobal, formerly known as the Auto-ID Centre since its inception in 1999, has been working toward developing standards for RFID protocols that can be used to define data structure and tag/reader interfacing for RFID systems (Dlouhy Merchant Group, 2004, p. 17). In late 2003, EPCglobal released its first-generation specifications for passive tags; however, this was not compatible with ISO-18000 draft standards. As a result, there was no acceptance of universal ISO-18000 standard for UHF communications for RFID systems.

Based on industry feedback, EPCglobal recently issued a Generation 2 protocol compatible with UHF frequencies from 860MHz to 930MHz. However, the VDC states that while the prospects of this standard are promising from the market development perspective, products compliant with this standard are yet to be developed, commercialized, and tested in real-world environments (Venture Development Corporation, 2005, para. 1). Furthermore, this standard applies to communication with passive tags only, and is yet to be approved by the ISO in order to be formally recognized as a truly global standard.

2.5.3 Tag Prices

The US$0.05 target price for RFID tags can be misleading (Dlouhy Merchant Group, 2004, p. 19) because it does not account for the applications that are driving the actual price well

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above this target price. Despite the estimated market growth of supply chain RFID applications, the variety of applications requires a diverse array of tags and is therefore a significant cost driver for RFID tags and an impediment to scale economies in manufacturing and adoption. The return on investments experienced through RFID implementations could form the basis for more informed decision making criteria with which future tag prices could be viably estimated.

As previously mentioned, improved manufacturing techniques combined with increased volume will be key determinants in lowering tag prices. While component costs may decrease with technological improvements, traditional manufacturing techniques will also need to decrease in order to enforce cost reduction. This could be challenging given the change of manufacturing techniques required to successfully manufacture newer (and sometimes smaller) technologies in higher volumes. Traditional automated equipment in production facilities will need replacements and modifications in the form of the latest manufacturing technology in order to successfully implement production runs of new tag technologies. In addition, if manufacturing time per tag does not decrease, then neither will production costs.

2.5.4 Challenges in Deployment

The performance of RFID systems can be significantly affected by the presence of metals and liquid nearby to tags, receivers, or antennas. Such environments pose some of the biggest challenges for widespread RFID adoption and implementation using UHF tags (Dlouhy Merchant Group, 2004, p. 19). Other issues, with severity dependent upon the application, include tag orientation (resulting in missed readings) and reader interference from multiple tags. Integrating existing business processes into new technological implementations and automations is often a very trying and cumbersome experience. Every implementation requires some degree of customization adding to the challenges of customer adoption. Execution of efficient planning and customer education can only be improved by the RFID vendor as it gains more field experience in

a number of different environments. While many of the deployment problems can be mitigated, the resolution of a given problem can often vary among different environments and pose a significant adoption barrier.

2.5.5 Privacy Issues

Opposition to RFID implementation stems from general paranoia relating to invasion of privacy regarding the potential ability of RFID systems to track human behaviour and location without prior consent or knowledge. Further concerns then relate to subsequent use of the acquired data.

Privacy concerns have been most prevalent amongst the Consumers Against Supermarket Privacy Invasion and Numbering (Dlouhy Merchant Group, 2004, p. 20), otherwise known as CASPIAN, and similar groups. Concerns of this group and other privacy advocates relate to the potential for unauthorized post-purchase tracking through tags on consumer items, data collection and consumer habit monitoring, and ill-health side effects from RFID radiation. The potential remedy to this issue may lie in consumer protection through government legislation and corporate privacy policies in addition to customer education regarding misconceptions about RFID. These privacy issues may not be particularly relevant to immediate or near-term markets given that item-level tagging is estimated to be several years away (Dlouhy Merchant Group, 2004, p. 20). However, the RFID industry needs to be prepared to face these privacy issues as the technology becomes more prevalent in new and existing markets.

2.5.6 Overall Impact of Forces

The forces discussed are collectively challenging wider spread adoption of RFID technologies and applications. In effect, these forces are restricting global adoption to the regional level due to standardization issues and conflicting protocols. As a result, widespread standardized products are unavailable, so the resultant limitation in economies of scale of

equipment and technologies is affecting costs at the component, deployment, and implementation level. While progress has recently been made toward standardization issues at the government and institutional level, products conforming to these standards are yet to be developed and tested for performance (Venture Development Corporation, 2005, para. 1). As long as these forces continue to be prevalent, uptake of RFID technologies will continue primarily at the regional level where the lack of standardization has promoted informal standards within the various RFID markets. However, there is a powerful driver in the RFID industry, namely Wal-Mart, which could not only affect future uptake and standardization of RFID technologies, but also drive down RFID costs to allow deployment at a widespread level.

2.6 The Wal-Mart Effect

Up until the middle of 2004, the adoption of RFID technology within more recent markets had been somewhat limited. For the most part, adoption of RFID technology within less mature markets has been by typical early adopter groups that are characterized as being affluent, venturous, big spenders, and risk takers, that are seeking dramatic improvements in operations,. Such firms are typically larger organizations and institutions such as transportation departments, hospitals, and construction companies to name a few.

In June 2003, Wal-Mart, the world's largest and most aggressive consumer products retailer, joined the RFID early adopter group by announcing a mandate that required its top 100 suppliers to incorporate RFID tags on its shipping cartons and pallets by January 1, 2005. Wal-Mart has met this schedule according to recent information (Roberti, 2005, para. 8). Furthermore, Wal-Mart expanded its mandate in July 2004 to include its next 200 largest suppliers by January 2006.

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2.6.1 Potential Impact on the RFID Industry

The ramifications of Wal-Mart's RFID initiative are significant when considering the size of the organization. The annual revenues of Wal-Mart are greater than the entire semiconductor industry; China exports more goods to Wal-Mart than to Japan; and Wal-Mart employs more personnel than the combined headcount of Ford, General Motors, Exxon Mobil, and General Electric (Roberti, 2003, para. 4). Hence, sheer size grants Wal-Mart the ability to make demands of its suppliers resulting in a shifting of economics within the RFID industry.

The volume of shipments for the top 100 suppliers alone is expected to result in one billion tags per year consumed (Williams, 2004, para. 5). Such volumes are likely to drive down prices for both tag and reader technologies. This effect is likely to have tremendous implications for further propulsion of RFID technologies into new markets and innovative applications by way of affordability and standardization. Furthermore, existing markets could expect to incur lower RFID equipment costs not only as these price reductions ensue, but also as standardization drives technological convergence. Hence, RFID applications and technologies that were feasible for only larger organizations would become obtainable to others. As Wal-Mart further extends its mandate in the future, further economies of scale and extended market applications would emerge, especially as the scope of the RFID application by Wal-Mart deepens within its supply chain and approaches the item-tagging level.

A successful RFID implementation by Wal-Mart and its supply chain would effectively begin a migration of RFID technology from the early adopter markets to the early majority markets and thereby serve as a bellwether for mass adoption (Security Systems News, 2004, para. 6). The early majority markets typically consist of adopters that have a follow-the-leader attitude, implement proven solutions, and wait for the development of standards. In turn, these early majority markets could then serve as a launch pad for further mainstream adoption and extended applications of RFID technology.

2.6.2 Potential Challenges

While Wal-Mart may be considered an early adopter, the same does not necessarily apply to its suppliers. The lack of innovation associated with these early majority or later adopters would be the reason for the suppliers' adopting a compliance-only attitude toward tagging their pallets and crates destined for Wal-Mart. Many of these suppliers are hesitant to invest in infrastructures that use platforms yet to be proven, standardized, and adequately supported. Consequently, while Wal-Mart has obtained RFID tagging compliance from its top 100 suppliers, full compliance may not necessarily be obtained from smaller suppliers that are unable to justify the additional expense for tags and potential infrastructure costs. These costs would inevitably need to be incurred by suppliers in the future as Wal-Mart chooses to deepen its control in the supply chain by connecting directly to the suppliers' RFID infrastructure. Hence, the Wal-Mart supply chain may experience a future shakeout of suppliers unable to comply with future requests.

Another potential challenge to Wal-Mart's RFID initiatives is the recent merger of Proctor & Gamble (P&G) with Gillette (Dignan, 2005, paras. 7-11). Many of Wal-Mart's top 100 customers have implemented RFID tagging for the sake of compliance, rather than for return on investment. However, P&G and Gillette have a total of 30% of sales to Wal-Mart, so the combined supplier bargaining power is significant. Furthermore, both P&G and Gillette are considered leaders in RFID and global data synchronization, so the merger may become a significant force in development of RFID standards and technological convergence.

Since Wal-Mart is considered the dominant player in the implementation of RFID, the extent to which its implementation is successful will have significant ripple effects throughout the entire RFID industry. Such effects will be visible by way of standardization of protocols, technologies, platforms, infrastructures, deployment, and implementation. In addition, component prices, equipment prices, and other effects from scale economies could transplant RFID

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technologies into the early majority markets where it could be used for additional applications. These effects would also promote widespread use among existing markets. In short, all the players in the RFID industry would benefit. However, the extent to which these ripple effects occur is dependent upon how well Wal-Mart copes with the challenges of RFID implementation within its supply chain. Even though there are other large early adopters of RFID supply chain implementations such as DOD, Tesco, Target, Metro Group, and others (Stephan, 2005, p. 21), Wal-Mart is expected to perpetuate ripple effects to a much higher degree.

2.7 Current Markets

Factors relating to trends, forces, and the Wal-Mart effect result in today's RFID environment. Despite the fact that RFID industry encompasses a seemingly unbounded application scope with respect to how its future will unfold, some markets are readily identifiable and already reasonably mature. Recent information reveals that the 2003 RFID marketplace consisted of the segments shown in Table 1 resulting in global shipments of RFID systems totalling US$1.128 billion (Venture Development Corporation, 2004). While accurate estimates of the actual 2004 market size are not available, the most recent estimates issued in March 2004 by the Venture Development Corporation (VDC) estimate global shipments of RFID systems in 2005 to be US$2.130 million (Venture Development Corporation, 2004) – almost twice that of 2003. The majority of this anticipated growth is expected in the early adopter markets.

Table 1   2003 Market Segments and Relative Proportions

Market Segment	Proportion of Total Market Size
Smart labels (EAS) (Electronic Article Surveillance)	0.3%
Baggage Handling	0.6%
Other	1.2%
Rental Item Tracking	2.2%
Point of Sale	2.4%
Library Systems	2.6%
Real-time Location Systems	2.9%
Animal Tracking	3.8%
Asset Management	7.9%
Toll Collection	11.3%
Transportation	12.9%
Automobile Immobilizers	13.3%
Supply Chain Management	15%
Security / Access Control	23.8%
TOTAL	100%

Source: Adapted from Dlouhy Merchant Group, 2004, p. 22

The more mature market segments have existed for over a decade and include most of the largest application segments from Table 1 such as Security and Access Control, Automobile Immobilizers, Transportation, and Toll Collection. Supply Chain Management is very much considered an early adopter market, but promises enormous growth potential (Dlouhy Merchant Group, 2004. p. 21) despite already having captured 15% of the total RFID market by the end of 2003. This promise is fuelled by immediate opportunities that RFID can provide such as reduction of stock shortages, simplified product recalls, reduction of labour costs, and elimination of product loss and theft. In effect, manufacturers and suppliers could experience significant increases in efficiency of forecasting, production, transportation, distribution and warehousing.

As supply chain related industries are expected to account for the largest RFID revenues in both short-term and long-term forecasts, it is widely expected that supply chain RFID products and implementation will be the biggest driver toward RFID applications and overall industry

growth in 2005. However, these annual growth rates are expected to be slower than those of the very early adopter markets: health care, commercial services, and retail services (Information Technology Association of America, 2004, p. 6).

Research by the Information Technology Association of America (ITAA) concludes that rapid growth is expected in Commercial Services with respect to automation of payment systems and mobile commerce. Rental and Loan organizations are expected to adopt RFID technologies pertaining to rental item and media tracking. Further developments are expected in the Retail sector for advancing electronic article surveillance (EAS) transponder technology (smart RFID tags) relating to information storage for purchasable items. In addition, there is increased interest among healthcare market businesses in applications relating to waste management, asset tracking, document tracking, and real-time location systems. eXI currently participates in two of the markets in which high growth is expected: real-time location systems and asset management.

2.8   Existing Markets and Products of eXI

Current eXI solutions are marketed in the healthcare, energy, and construction industries. The majority of the firm's customers are in the Healthcare sector. Unlike its competitors, eXI is able to serve its different markets with common technology platforms thereby enabling the firm to leverage applications among its markets. eXI has established over 1000 installations in healthcare-related asset management, tracking, and patient security markets. These markets are served with three RFID product solutions: RoamAlert, HALO, and Assetrac.

In addition, the company serves asset management software and auto identification technology solutions to the construction, energy, and heavy industrial markets. These markets are served with eXI's line of HOUNDware solutions: Tool Hound III, HOUNDware OnSite, and HOUNDware OnLine.

2.8.1 Healthcare

Serving hospitals and birthing centres, eXI provides its HALO system to protect infants from abduction. eXI active tags are attached to infants and send out signals to the monitoring system both periodically and in the event that the tag is removed. The HALO software processes the signals, displays locations of alarms, and integrates with the facility's other systems when required.

Used in nursing homes and other assisted living facilities, eXI provides its RoamAlert system to protect residents from wandering. Residents wear active tags to prevent them from entering restricted areas or wandering off the facility. Similar to the HALO software, the system can be configured to generate an alarm and display where the alarm has occurred.

Offered to medical facilities, Assetrac is available as an RTLS solution that can be integrated with access control, closed-captioned television, and other types of security systems. Assetrac is designed to keep track of assets such as computers, medical equipment, and test tools. Assetrac is also available as a scaled down version called ProtecPoint that is designed for security applications only and does not encompass the tracking functionality.

2.8.2 Industrial

Serving the construction, energy, and heavy industry markets, Tool Hound III provides asset protection and monitoring. The system provides many mobile asset monitoring functions including inventory control, checkout and return, replenishment, maintenance, calibration, and rentals.

Within these markets, the Tool Hound III application can be extended through upgrades. One upgrade is HOUNDware Onsite which is web-based and enables company-wide sharing of data by intranet. Similarly, HOUNDware Online allows for organization-wide sharing of data by

internet to serve firms with multiple physical locations. HOUNDware solutions are used for check-in and check-out of various assets and tools.

2.9 Summary of the RFID Industry

This chapter presents a current overview of the RFID industry with an emphasis on the potential effect of RFID from the supply chain market. The enabling nature of RFID technologies and the impact on the value chain suggests that industry boundaries are not obvious and are represented as an unbounded collection of trends and forces which respectively serve to grow and constrain the potential reach of the application of RFID. Subject to these and additional factors, the implementation of Wal-Mart's RFID objectives will have a significant impact on the future state and uptake of RFID. Despite the factors affecting the RFID industry, markets can be identified and are at various stages of maturity. Of the identified markets, eXI is currently participating in those of real-time location systems and asset management. The analysis of the RFID industry continues in the following chapter, but instead turns to the market of interest to eXI – the Containers market.

3 Containers Market

The increasing size of the Containers market, combined with the government and corporate initiatives that are driving it, has peaked the interest of eXI. Furthermore, the Containers market is an application of active RFID tags, the development of which is a strong competence of eXI. Hence, eXI would like to investigate this market in order to develop a potential entry strategy. This chapter investigates the factors and implications relevant to the adoption of RFID technologies and infrastructures for containers tracking and security in order to determine the market dynamics that will affect entry into the Containers market.

This chapter begins with a market overview and addresses the requirements and benefits of using RFID solutions for containers tracking and security. The next two sections discuss existing factors that are not only promoting, but also hindering adoption of RFID technologies for container tracking and security. The major players and partnerships developing the RFID infrastructure and equipment for container security are then overviewed in terms of their product and service offerings. Finally, implications related to the findings are discussed.

3.1 Containers Tracking and Security

In 2004, the World Customs Organization monitored worldwide shipments of an estimated 11 million containers (Fickes, 2004, para. 8). In the United States alone, 7,500 commercial vessels delivered 6 million containers to American ports. Further estimates suggest that within 20 years, 24 million containers will be delivered annually to the United States. The ITAA estimates that supply chain related applications, such as the Containers tracking and security, will be the biggest RFID market segment from 2005 through 2009 (Information

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Technology Association of America, 2005). This is hardly surprising when considering the

following facts (Cohen, 2005, p. 1):

1. 17 hand-offs associated with the average international container;
2. 100,000 documents on average are required to track a container and its contents;
3. 80% of the world's cargo moves by sea;
4. 445 seaborne piracy attacks occurred in 2003;
5. Only 5% of the millions of containers reaching the United States each year undergo inspection; 2% of containers shipments worldwide undergo inspection (Kevan, 2004, p. 46).
6. 80% of trade in the United States passes through only 3 ports;
7. $50 billion annual estimated loss due to cargo theft (Kevan, 2004, p. 46).

RFID applications for containers relate to not only tracking, but also securing containers

by way of affixing a seal to the container doors to detect whether any tampering has taken place.

The RFID seal contains a tag that functions not as a lock, but as a tampering detection device.

While conventional security seals will provide evidence of tampering, visual inspection is

required to verify. Under such circumstances, evidence of tampering can be discovered after the

fact and will offer little benefit other than proof of loss. Alternately, RFID seals can

automatically alert personnel at the time of tampering. These tamper-evident or "smart" seals are

active RFID tags and can broadcast that the container has been opened or removed without

authorization. In addition, some smart tags can even monitor and transmit information pertaining

to environmental conditions inside the container (Mullen, 2005, p. 2).

The level of interest regarding supply chain security has risen sharply since the

September 11, 2001, terrorist attacks in the United States. Concerns of security experts focus on

the possibility of terrorists accessing the containers for the smuggling of goods varying from

radioactive materials to explosives or weapons. The tamper-evident secure container (TESC),

which is fitted with a smart seal, addresses these concerns and is expected to cost about US$100

above the standard container cost of about US$2,000 (Greenemeier, 2005, para. 9). Although

security is the main objective served by the container seals, the smart seal can be designed to

provide additional information thereby yielding productivity gains within the supply chain. For example, the smart seal could be used to identify the container's location and progress during transit.

Despite the potential gains from RFID tagging of containers, the shipping industry is not ready for mass adoption of TESCs (Greenemeier, 2005, para. 19). With container replacement rate averaging 10% per annum, full turnover could take over 10 years. In light of the slow adoption rates expected, some firms, such as General Electric (GE), for example, are implementing the RFID tag for containers in a standalone form without tampering detection (Greenemeier, 2005, para. 8) to lower tag costs and provide immediate advantages for shippers including the following (A. T. Kearney, 2005, para. 5):

1. Reduction of Inventory due to improved visibility throughout the supply chain;
2. Reduction of stock-outs resulting from improved scheduling accuracy;
3. Reduction of safety stock and inventory carrying costs from improved in-transit visibility;
4. Enhancement of customer service to sales channels and resellers from availability of current information;
5. Increased profits from improved in-stock product rates;
6. Reduced administrative costs and fees from the automation of monitoring and security;
7. Prevention of theft and lost containers due to improved tracking capabilities.

The resultant cost savings are estimated to be about US$1,200 per container. Furthermore, if the RFID tag for the container is a smart seal, additional benefits emerge such as prevention of content theft and container loss due to improved tracking and monitoring capabilities, and automation of data collection through the RFID infrastructure at any location. In addition, significant cost and time savings could be realized due to reduced costs related to emerging customs security measures (Study proves cargo security, 2004, para. 3). Hence, a triple-bottom-line benefit in productivity gains arises when utilizing smart seals: reductions in security clearance costs, improved container security, and increased supply chain visibility.

3.2 Factors Promoting Adoption of RFID Technologies within the Containers Market

The biggest driver in the security and tracking of Containers is the Operation Safe Commerce (OSC) program of the United States Department of Homeland Security (DHS). Shortly after the terrorist attacks of September 11, 2001, the DHS launched the initiative called Customs-Trade Partners Against Terrorism (C-TPAT) in April 2002 through the DHS subsidiary division, United States Customs & Border Protection (CBP). C-TPAT is a government-business joint initiative to strengthen supply chain and border security by building close cooperative relationships with importers, carriers, brokers, warehouse operators, and manufacturers. C-TPAT launched with 7 participating companies and has over 7,400 companies participating today (U.S. Customs and Border Protection, 2004, p.2). The benefits to those organizations wishing to join C-TPAT include reduced number of inspections, an assigned account manager (if one is not already assigned), access to the C-TPAT membership list, eligibility for account-based processes, and an emphasis on self-policing, not Customs verifications (C-TPAT fact sheet, n.d., Benefits of Participation section, para. 1).

In September 2004, the DHS announced that high-security container seals will be mandatory by September 2005 for all containers incoming to the United States (Tirschwell, 2004, paras. 1-5). Container seals have already been adopted as a requirement of the C-TPAT program. However, current requirements dictate that only mechanical seals are required to be used. Given the multiple handoffs that a container ensues from assembly plants to trucks to marine terminals to carriers, there are numerous opportunities for foul play including seal violation and replacement.

In order to monitor the seals, constant surveillance of the containers is required which is no small task when thousands of containers are onsite. Hence, a centralized method of monitoring the seal is literally mandatory to ensure the integrity of the seal and the security of the

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containers contents. As a result, the DHS started its C-TPAT Plus initiative that yields green lane

clearance (no inspection upon arrival) for containers of C-TPAT members that utilize the smart

seals developed by Savi Technology (A. T. Kearney, 2005, paras. 1-2). These smart seals can

monitor tampering from the point of origin and provide inspectors with a record of events (Using

RFID, 2005, para. 2).

Another initiative launched by the DHS and CBP in January 2002 under the OSC

program is the Container Security Initiative (CSI). Under this project, containers that pose a risk

for terrorism are identified and examined at foreign ports by American officials before they are

shipped to the United States. Intelligence and automated information is used to identify

containers posing risks for terrorism. These containers are then prescreened at the port of

departure using specialized detection technologies. Under this initiative, the use of TESCs is

required to receive security clearance at points of origin and destination (CSI in brief, n.d.,

para. 2).

Another driver promoting adoption of containers tracking and security solutions is the

Smart and Secure Trade Lanes Initiative (SST), an industry-driven supply chain security initiative

launched by the Strategic Council on Security Technology. The SST initiative focuses on

deployment of an end-to-end, global supply chain security solution by incorporating secure

business practices and advanced technologies with partners such as terminal operators, carriers,

service providers and shippers (Strategic Council on Security Technology, n.d., paras. 1-2). SST

initiatives have included pilot projects in Africa, Asia, Europe, United Kingdom, Latin America,

and the United States to improve safety and security of containers shipping (Vendor Initiative,

2005, paras. 1-2). SST systems have been installed at more than 15 ports and so far, more than

2,000 containers sealed with active RFID sensor bolts have been shipped in SST-related programs

(Collins, 2005, February 2, para. 9).

Hence, the C-TPAT, CSI, and SST initiatives are collectively driving forward the adoption of RFID technologies for containers security and tracking applications. C-TPAT initiatives by the DHS relate to container security at U.S. Customs checkpoints. DHS takes this level of security one step further through the CSI by establishing U.S. security checkpoints for high risk containers at foreign ports. Through the industry-driven SST initiative, the level of security and safety is further extended to containers tracking and security throughout the global supply chain.

3.3 Factors Preventing Adoption of RFID Technologies within the Containers Market

The various initiatives that are driving the adoption of RFID technologies and infrastructures within the Containers market have arisen primarily in light of increased security requirements in the United States after the terrorist attacks on September 11, 2001. Combined with the RFID supply chain initiatives by Wal-Mart, DOD, and other early adopters, there is increased pressure upon shippers, transporters, manufacturers, and users of containers to adopt RFID technologies for tracking and security applications. Although RFID technologies are promising for these applications, there are several barriers to adoption.

Implementation challenges within the container warehouses range from non-functional tags to environmental conditions (such as temperature and humidity) to radio interference from other RFID tags and wireless devices. As the containers are loaded onto trucks and other forms of transport, the RFID tags can be damaged or moved out of optimal alignment for data transmission. Furthermore, cold outdoor temperatures can cause the tag adhesive to fail. When containers are transported to new storage locations, additional challenges can result such as the incompatibility of container tags and warehouse readers (Brandel, 2004, p. 32) and their proximities relative to each other. The metallic nature of the container itself can cause the reliability of RFID tag read-rates to drop as low as 15% (Brandel, 2004, p. 33). These challenges

in implementation have prompted the Customs Operations Advisory Committee to recommend that a mechanical seal (non-RFID) regulation be implemented by September 2005 as a requirement for all inbound containers into the United States (Tirschwell, 2004, para. 9).

These challenges in implementation, in conjunction with the challenges and costs of RFID deployment discussed in sections 2.5.3 and 2.5.4, are typical results of an application that is still in its infancy, and can often lead to apprehensiveness concerning whether the RFID implementation will ever come to fruition. IDC estimates that a typical early adopter for safe commerce IT solutions will spend about US$3.7 million (Cohen, 2005, p. 1). According to results from a containers security tracking survey performed by ABI Research (ABI Research, 2004, Electronic container tracking, pp. 4-15), apprehensiveness is prevalent among the survey participants, many of whom have taken a wait-and-see attitude due to the inherent lack of standardization in terms of products, performance, pricing levels, and regulation, for tracking and security of containers (O'Connor, 2004, para. 4).

The lack of standardization is a predominant issue among those in the container security and tracking industry. The survey participant feedback suggests that the lack of government mandates is preventing widespread adoption of containers tracking solutions. ABI Research believes that widespread adoption of any container tracking technologies will not occur without government mandates (Collins, 2005, February 2, para. 11). According to ABI Research, most of the players in the container security and tracking industry are waiting for the DHS and other national border agencies around the world to decide on technical standards (O'Connor, 2004, para. 3).

The added costs of implementing and deploying the RFID infrastructure pose the question as to who is responsible for the costs given the number of times that a container changes hands during transport – the many different sectors involved all have a stake in containers

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tracking and security. Container transport in general entails a large number of handoffs and complex interactions between the manufacturer, shipping line, ports, marine vessels, dray operators, and other members of the transport value chain. Inter-modal transport becomes even more complicated as the container moves between rail, sea, and land. The $1,200 savings associated with RFID tracking and security of containers is effectively distributed throughout the transport chain. The distributed nature of these savings not only complicates the situation regarding who should pay for the costs of RFID deployment, but also serves as a barrier-to-adoption for each intermediate element in the transport value chain given the relatively high costs of deployment in comparison to the cost savings. Major providers of RFID equipment within the Containers market, such as General Electric, are trying to mitigate this issue by covering some of the infrastructure costs as explained in further detail in section 3.4.2.

The costs of deploying RFID infrastructures entail several considerations (Moore, 2004). Implementation of RFID introduces new business processes for tracking and security of containers which means that costs of implementation will also include revamping existing business processes to accommodate the RFID implementation. In addition, there will be the cost of testing and developing a site-specific RFID container tracking and security system, the existing challenge here is that there are a number of different software platforms, tags, readers, and available which offer limited compatibility and interoperability. Furthermore, different tags may exhibit varying degrees of successful functionality depending upon the operating environment and choice of readers and software. In light of this, there is no guarantee that containers received will be equipped with tags that are compatible with the RFID infrastructure that has been installed at a given location.

The lack of standardized products, protocols, and technologies, gives rise to uncertainty regarding the attainable return-on-investment (ROI). The true value of ROI can only be realized through the use of standardized RFID products and protocols throughout the transport value

chain. For example, it cannot be possible to identify choke points within the supply chain, such

as where containers are spending too much time in a port, if the RFID infrastructure installed at

the port is unable to read the tag data due to hardware or software incompatibility. Hence,

maximization of ROI can only achieved through international standardization of RFID for

containers tracking and security. Therefore, ABI Research has concluded from its research that

only through government mandates will the industry achieve significant volumes of

electronically-tracked containers (Collins, 2005, February 2, para. 15).

3.4 Major Players and Partnerships in Containers Tracking and Security

All of the major players in the application of RFID to containers tracking and security are

participating in the C-TPAT, CSI, and SST initiatives of the DHS. The major players are

responsible for the driving forward the adoption of RFID for containers tracking and security by

way of their product and service offering. Although ABI Research identifies 96 companies

offering various types of solutions for containers tracking and security (listed in the Appendix),

there are only a few main players providing complete integrated solutions from shipment origin to

destination such as: Savi Technology, General Electric, Unisys, and RAE Systems. These are

some of the few companies that are driving the adoption for RFID specifically for containers

tracking and security. They are well rooted in supply chain applications planning and

implementation and have experience, expertise, and have developed applicable products and

technologies. Major players comprise of not only technology and solutions providers, but also

members of the various government initiatives that are adopting these offerings.

3.4.1 Members of the Smart and Secure Tradelanes Initiative

Members of the SST include Hutchison Port Holdings, PSA Corporation, and P & O

Ports (Vendor Initiative, 2005, para. 3). Collectively, these three organizations control 70 percent

of global container port operations. Other members include international shippers from 13

industries. Technology vendors such as Symbol Technologies, Intermec, EXE, Savi Technology

(Savi), E.J. Brooks (Brooks) and Manugistics, are also part of the SST initiative. The SIMTAG

Consortium, a European-based union involved with safety and security of global cargo is also

allied with SST. SST members are involved with over 80 percent of global container shipments.

3.4.2 General Electric and China International Marine Containers Group

General Electric (GE) and the China International Marine Containers Group (CIMC), the

world's largest container manufacturer, recently completed field tests of RFID technology for

securing cargo containers (Newswire Digest, 2005, para. 1). The TESC integrates GE's smart

seal known as the CommerceGuard with a standard maritime container. CommerceGuard

consists of an integrated security sensor mounted to the inside wall of each TESC and is armed

after the container is sealed with a standard bolt seal (Greenemeier, 2005, para. 3). GE is

preparing to finance installation of its RFID infrastructure in 2005 at various ports throughout the

world (Collins, 2005, January 12, para. 17). GE has worked together with CIMC to develop new

containers with door hinges on the inside of the container. These new TESCs are slated to be

available for sale during the third quarter of this year. Unisys has managed the testing and

provided integration services. CommerceGuard can also be used to provide in-transit supply

chain visibility.

GE will install its RFID readers at all ports participating in the CSI to encourage early

adoption for its technology. As of January 2005, 32 ports were participating in the program, but

the total is expected to increase to 40 ports by the end of 2005. GE will work to see its

technology adopted as an industry standard, so the company plans to eventually move toward

licensing the patented technology to other vendors (Collins, 2005, January 12, para. 17).

3.4.3 Department of Defence, Savi Technology, and Unisys Corporation

The DOD already utilizes active RFID technology on its cargo containers using a system developed by Savi that is integrated with systems from Unisys. Since 1994, Unisys systems have underpinned the world's largest RFID network created by the DOD (Collins, 2004, October 5, para. 2) and are integrated into over 20 visible commerce implementations and pilots in consumer electronics, life sciences, apparel, retail, food and beverage, airlines, banking and government (Cohen, 2005, p. 17). Unisys has a global infrastructure that can support RFID implementation anywhere in the world as illustrated through the DOD network that operates across 30 countries. Unisys is also involved in OSC projects through the port authorities to improve safeguards for containerized shipping. The RFID system of Unisys is developed in conjunction with a number of partners including: Microsoft (for software architectures), GlobeRanger (for RFID middleware), Tradebeam (for risk and document management software), and Manugistics (for inventory and supply chain management software). Unisys has developed its own software suite for improved visibility including: In-Transit Visibility, ePedigree, and Chain-of-Custody.

3.4.4 Savi Technology and Related Partnerships

Savi has been working for years with the United States military for defense logistics applications involving container tracking (Maselli, 2003, para. 3), and specializes in using RFID for visibility in supply chain networks. Savi helped develop the military's Total Asset Visibility network which is the world's largest RFID logistics tracking system (RFID Journal, 2003, para. 2). In addition to the sensor bolt for container door hinges, Savi has developed its own smart seal – the Sentinel. It is mounted inside the container door and uses sensors for light and pressure to determine whether unauthorized container access has occurred and thereby transmits an alarm signal. Furthermore, integrated environmental sensors measure temperature, humidity, and shock for the duration of the container's journey to allow for various elements of the transport value chain to monitor internal container conditions to prevent spoilage or damage to

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the goods in transit. Information such as time stamps, location, and other sensory data is stored by The Sentinel and can be captured by readers at various port facilities. Additional sensors can be added to The Sentinel as needed.

The Sentinel links to Savi's Transportation Security System (TSS) to assist with journey planning for all tracked containers and interface with logistics software, enterprise resource planning systems, and warehouse systems. The TSS is then able to map workflow events throughout the supply chain and generate alerts relating to discrepancies or delays. The software portal for SIMTAG receives data from this system to then create the journey plan for the shipment to within one mile of the intended destination (Vendor initiative, 2005, para. 5).

The Sentinel has been tested at the ports of Tacoma and Seattle, and is currently being tested by Hutchison Port Holdings. Savi has recently partnered with companies such as Symbol Technologies and Zebra Technologies to provide supply chain RFID solutions to provide RFID tag and integrate related information at the carton, pallet, and container levels (Business Wire, 2005). In addition, Savi will supply the RFID software and equipment to be used in South Korea's largest and busiest port, the Port of Busan (Collins, 2005, March 10, para. 1). This particular deployment will act as a central focus for Savi and LG CNS to form a strategic alliance to co-market, integrate, and implement Savi's software and RFID offerings.

Savi's most recent partnership has been with Comtech Mobile Datacom (CMD) to develop an integrated tracker to identify cargo in-transit (Food Production Daily, 2005, para. 1). The jointly developed solution entails commercial users mounting a two-way communication kit to the roof of the truck driver's cab, enabling the central monitoring location to locate, manage and redirect cargo in near real-time. CMD's Movement Tracking System integrates Savi's mobile active RFID tag reader with CMS's mobile satellite transceiver and Comtech's worldwide GPS location and satellite communications system. The active RFID tag reader reads Savi's

active RFID tags affixed to containers and other cargo transported by the vehicle. The CMD

system then uploads the data, including GPS location, via an embedded satellite modem to a

satellite system to communicate with the customer's server and software system. CMD's

Movement Tracking System also provides the driver with near-real-time messaging capability.

The net result is a mobile infrastructure to continuously track and manage consignments, supplies

and material from the factory.

3.4.5 RAE Systems

The RFID sensors in The Sentinel can only be monitored when the container has reached

a destined port or stop. RAE Systems has taken this potential shortcoming one step further by

designing an RFID tracking system that utilizes a powerful transmitter on the ship to transmit

container information via satellite (Kevan, 2004, p. 47). The system includes RAEWatch RFID

sensors for detecting nuclear, biological, or chemical threats, and can therefore identify potential

threats before the ship arrives at port. These sensors are expandable to include a variety of other

sensors.

RAE Systems integrates automated global trade management solutions with its wireless

integrated security sensors to streamline and automate information exchanges associated with the

international movement of goods. The data provided by RAEWatch wireless sensors are not

software specific and can integrate with any logistics system or database to merge the containers'

identification and security status with shipment and manifest data (RAE Systems, 2005, p. 5).

Should a container undergo a security breach, the wireless sensor sends a signal to the database to

flag the container for inspection before clearance through Customs.

RAE Systems is implementing a leading edge concept known as pervasive sensing (RAE

Systems, 2005, p. 5). The implementation of pervasive sensing consists of RAEWatch wireless

sensors that can self-configure into wireless networks or mesh networks with adjacent or nearby

RAEWatch sensors to facilitate the communications process by providing multiple data transmission paths for information from a given sensor to reach the RFID reader.

3.4.6   Aeroscout Incorporated

A number of smaller players, such as Aeroscout for example, are offering container tracking solutions at a localized level, rather than a global level, to improve efficiency at the facility. Such systems are basically asset-tracking systems for containers. The Aeroscout Visibility System (AVS) is an integrated suite of hardware and software products utilizing active RFID tags placed on assets to provide location information via a Wi-Fi network (Kevan, 2005, para. 2). The data is sent to the AeroScout Engine that manages the collection and processing of location data and passes it on to back-end business systems. The Aeroscout Exciter is positioned at entry points of facilities to turn tags on and off, and change the frequency and the channels over which the tags transmit. It can also store short messages on the tags that can later be retrieved.

American Port Services, a large transportation logistics provider in the southeastern United States, has deployed the AVS at its docking facility in Savannah, Georgia. Tags are temporarily placed on containers as they enter the yard. As containers move throughout the yard, the tags transmit on a periodic basis, and the readers pick up the messages. The AVS software utilizes triangulation algorithms to determine the tag locations of the, and then passes the information to the Total View application which is integrated with the yard management software on-site.

3.5   Implications of Entering the Containers Market

Although there are currently only several major players in the Containers market, there is significant variation in the maturity of devices available when considering the 96 companies listed in the Appendix that are offering solutions for container tracking and security. Some of the

available e-seals exhibit more advanced levels of design and experience and product support from the vendors such as Savi (Chin & Wu, 2004, pp. 98-101). Although the products and technology are available in the market; only a few vendors such as Savi and GE have had significant previous deployment in actual operations and have developed valuable experience in actual problem solving and optimization. These factors have a major impact on the ability to achieve acceptable system performance in an operational environment.

The study by Chin & Wu (2004, pp. 98-102) shows a clear need for standardization of electronic seal design and operational attributes given the vast selection of solutions and providers. To achieve compatibility among any container tracking devices used by the various carriers and shippers in the industry, a set of standards permitting communication between seals and readers from various manufacturers will have to be developed. Without standardization in place, the cost of the infrastructure build-up will remain costly due to the fragmentation of the product offerings and will therefore hinder adoption. However, reaching a standard will be challenging since it involves specifying operating frequencies, data formats, communication protocols, seal and reader locations, and reader/tag design features. Moreover, the standards should allow for interoperability among competing products, container tags, and RFID infrastructures at facilities throughout the transport value chain. Effectively, the entire supply chain security requires global collaboration between governments, industries and individual businesses to ensure that the entire logistic process is secured and standardized.

Hence, eXI must recognize that the current lack of standardization of RFID technologies for containers tracking and security will pose a significant challenge in gaining acceptance for its potential product offering. Furthermore, as eXI chooses to participate in the various initiatives driving the adoption of RFID within the Containers market, the organization will be faced with intense competition from large players and partnerships that have dominated RFID supply chain applications. It is for this reason that eXI must attempt to provide a unique offering to the

Containers market so as to gain an un-imitable competitive advantage as part of its strategy. In order to accomplish this, it is necessary to analyze the capabilities that exist internally to eXI, which is where the true core competences and resulting competitive advantages reside. Hence, the following chapter looks at eXI at a deeper level to analyze the internal competences and capabilities of the firm in order to determine how it can leverage into the Containers market.

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4 Unique Competences and Resources

Successful market entry of eXI into the Containers market will be attributable to how well eXI is able to leverage its available resources to position itself competitively. In order to achieve this positioning, the competences which currently provide competitive differentiation in eXI's current markets must be evaluated to determine how they can serve as a basis for competitive advantage in the Containers market. Additional competences and resources can then be assessed to determine how they can support and thereby enable the competitive advantage.

This chapter begins by discussing the capabilities upon which eXI has achieved success in its existing markets. These are the intangible resources that eXI has built up since its inception almost 20 years ago, and consist of core competencies and patents. Organizational resources that transform the core competences into customer products are then discussed with respect to potential changes required to support new core competences to address the new market. The last section then discusses the availability of external partnerships and resources that can result in potential synergies to the help launch the firm into the Containers market. Strategic alternatives based on the findings of the analyses of the RFID industry, Containers Market, and internal competences are discussed in the next chapter.

4.1 Intangible Resources

Intangible resources relate to intellectual property and knowledge-based assets such as core competences, innovation abilities, knowledge, reputation, patents, and trademarks. Based on its core competences, eXI has developed capabilities and innovation abilities in the areas of low power RFID system design, middleware platform development, and has developed three patents

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in the areas of anti-collision protocols to prevent errors when readers receive data from multiple tags, and tamper detection of active RFID tags. In addition, eXI has built up its reputation for almost 20 years as a pioneer in the development of RTLS technologies and systems, and the application of RFID.

4.1.1   Core Competences

Core competences comprise of the activities, knowledge, and skills that collectively serve to provide advantages to the firm that are difficult to imitate by other organizations (Johnson & Scholes, 2002, p. 18). These are the activities, processes, and capabilities that critically underpin competitive capability by creating and sustaining the ability to fulfill the critical success factors of particular customers or markets in better ways than other organizations. Hence, core competences form a logical and ideal basis upon which to develop new strategies to enter into new markets. The competitive advantages resulting from core competences at eXI are in-depth knowledge concerning low power system design and middleware platform development. Furthermore, these advantages have given rise to patents for eXI relating to an anti-collision protocol and tamper-proof technologies. These competitive advantages and patents are examined next followed by a discussion of the core competences that underlie these capabilities and outcomes. The extent to which the competitive advantages and patents can be used to leverage into the Containers market is discussed in detail in section 6.3.

4.1.1.1 Low Power Design

Knowledge in lower power active RFID design has given rise to eXI designing the world's smallest active RFID tag which is part of its HALO system. The core technology of a typical active RFID tag consists of two integrated circuit chips: a microprocessor for data storage and communications, and a controller for data transmission and reception. During the development of the active RFID tag for the Halo system, eXI worked to replace the controller

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chip with a design utilizing discrete components in order to lower the power consumption of the tag. This enabled the firm to not only lower power consumption, but also develop the smallest active RFID tag, and subsequently reduce the required battery size.

This small active RFID tag is the result of three years of development efforts and has resulted in engineering knowledge and capabilities gained in low power design for RFID applications. Furthermore, the firm has gained expertise in the miniaturization of RFID technology implementations and related manufacturability issues. The small RFID tag has undergone incremental modifications since its initial launch in 1999 to yield improvements in performance, power consumption, and communication protocols. As a result, the firm has built-up 9 years of knowledge regarding the miniaturization of active RFID tags. Hence, designing intelligent, small scale, low power tags is a competitive capability for eXI. The knowledge base at eXI has been built up over time, and comes only with experience specific to this particular subject area, and is therefore hard to imitate by other companies.

The competitive advantage resulting from this particular capability is critical to the product offering of eXI because it results in a miniaturized RFID tag that is unobtrusive to the wearer. While the technical functionality of the tag has been improved continually over the years by way of design enhancements and modifications, it is also important for eXI to monitor the competing technologies. These competing technologies, such as chipless tags, flexible tags, and printed electronics (previously discussed in section 2.4.1) may offer further gains for miniaturization not only to eXI, but also to the competition. Hence in order for eXI to preserve its competitive edge with regards to its active tag technology, it will need to consider utilizing emerging new technologies as part of the continual process of evolving its competitive capabilities in low power design. Only in this manner can the competitive capabilities be renewed thereby allowing eXI to sustain its competitive advantage in these competences.

4.1.1.2 Middleware Platform Design

In 2004, eXI developed its first software platform capable of integrating a variety of RFID systems. This solution is called e-Tegra and is the company's first middleware platform developed to support the full range of available ultra high frequency (UHF) tags and readers. eXI active tags communicate at 433MHz while those of other RFID systems can use a number of different frequencies over the UHF spectrum (328.6MHz to 2.9GHz). In addition, the e-Tegra platform is capable of integrating a wide variety of security and tracking applications such as bar code systems and video surveillance applications. The e-Tegra software currently works with the existing host or network controllers from eXI, HOUNDware, and Verichip, and can be customized to work with others. The combined functionality of e-Tegra with the eLink Network Manager results in data translation and condensing of information within the network controller before sending it to the main server for applications processing.

In addition to performing the middleware role connecting RFID readers with enterprise applications, e-Tegra software contains decision-processing and location awareness capabilities for eXI systems, enabling them to automatically respond to RFID reads and tag associations. For example, the software could automatically associate assets with staff members or raise alarms when items or individuals leave defined areas. This performance is new functionality to RFID middleware and development of this value-added capability can be considered a competitive capability. This competence reflects the extent to which eXI understands hardware and application server communications and is able to develop middleware to effectively increase the overall functionality of the system. Thus eXI is able to produce intelligent or "agile" middleware.

It is important to note that this particular competitive capability is relatively new to the firm, in comparison to competences in low power design which developed over nearly a decade. The concept of intelligent middleware is new to the RFID industry, so the recent press release (Collins, 2004, November 4, para. 1) will inevitably result in the attempted development of

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competing software platforms. Hence, in order to sustain this competitive capability, it is imperative for eXI to renew it on an ongoing basis. This would involve scanning the environment for competing technologies that may complement or deepen this competence. However, given the relative newness of the concept of intelligent middleware, such competing technologies may not be readily available. Hence, higher emphasis should be placed upon renewing the intelligence of the middleware during the interim by utilizing available resources in order to ensure this new core capability is sustained and deepened so as to provide ongoing competitive advantage.

4.1.2 Patents

eXI has obtained a total of three patents for its anti-collision protocol design, skin-sensing technology, and tamper proof tag detection design. These patents were developed at eXI and contribute value-added functionality and differentiation to its RFID systems.

4.1.2.1 Anti-Collision Protocol Design

In 2002, eXI developed its communications protocol called eLink. This protocol prevents signals from multiple tags from interfering with each other when communicating with the reader. Furthermore, this protocol helps to conserve battery life of the active tag by transmitting signals to tags to put them into a sleep mode. Most anti-collision protocols require active tags to remain awake when communicating with the reader until all their serial numbers are read (RFID Journal, 2002, para. 2). The eLink protocol is embedded in the eXI middleware and therefore communicates with the eXI host or network controller, otherwise known as the eLink Network Manager. Although, this protocol can work with as many as 16 million tags, the processing efficiency of the eLink algorithm decreases after about 400 tags, so eXI is currently working to improve upon this. Through its anti-collision protocol design, eXI has effectively extended its competitive capability in low power hardware design from active tag hardware to

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middleware development, so its eLink communication protocol is a result of capabilities in both low power hardware design and middleware development.

The patented eLink protocol is a critical component of all RFID systems developed at eXI that enables deployment of low power RFID implementations for asset protection and location applications. Hence, the protocol creates value for eXI by enabling its systems to be deployed utilizing its unique low power architecture and anti-collision prevention. eXI systems are valued for these features and ranked among the top systems for the Healthcare markets. Since communication protocols form the basis upon which RTLS systems are implemented, there are no issues around patent crowding for RFID communication protocols. Innovations regarding RFID communication protocols and patents are demonstrated by way of overall system performance and attributes.

4.1.2.2 Tamper-proof Technologies

The infant tag for the Halo system is designed with a patented skin sensor that can automatically detect when the tag has been removed and thereafter activate the tag to send an alarm signal to the reader. This skin sensing technology is only available for the Halo infant tag, although a similar feature has been designed for the Assetrac active tag.

The active tag for the Assetrac system is designed with a contact-sensing mechanism that can detect when the tag is removed from the surface of the asset to which it is attached. As with the Halo system, the tag generates an alarm signal and transmits it to the reader.

The extent to which these patent benefits can be extended into the Containers market is questionable. The skin-sensing circuitry for the infant tag would require redesign to work on the metal surface of a container. The contact-sensing mechanism for the Assetrac active tag would only work in applications where the sensing pin is in direct contact with the metal surface of the container. So while these Tamper-proof patents provide a competitive advantage for eXI active

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tags in the Healthcare markets, the nature of the application in the Containers market will determine the degree to which the existing patents can be leveraged for competitive advantage.

4.1.3 Implications of Intangible Resources

The intangible assets at eXI are a result of over 20 years of experience in the research and development (R&D) of RTLS systems. Moreover, eXI has domain specific expertise relating to the Healthcare markets in addition to concentrated experience in RTLS technologies and systems design. Although the intangible resources evolved while developing RTLS solutions specifically for the Healthcare sector, they can be leveraged into other RFID applications because these specific competences and assets relate to knowledge, experience, and expertise that is specific to RFID, as opposed to being specific to the application of RFID in a given market. In other words, the source of these particular competences stems from a technical understanding of RFID technologies and systems development, rather than market specific knowledge.

As evident through its success in the Healthcare marketplace, eXI demonstrates its knowledge in customizing products for the applicable market. For example, competences in lower power design developed from identifying the market need for smaller unobtrusive tags and extended battery life. Similarly, capabilities in middleware platform design evolved from not only realizing the growing need for increased compatibility among vendor hardware, but also recognizing that developing intelligent middleware would allow software users to interface the RFID system using common interfaces, such as Microsoft Internet Explorer, without sacrificing overall system intelligence. Patents demonstrate the ability to sympathize with customer issues concerning the need for unobtrusive solutions. Overall, the analysis of intangible resources at eXI reveals that the company has core capabilities in product customization resulting from an overall sensitivity to market conditions and requirements. These core competences underpin the

firm's competitive capabilities and represent the company's values to deliver reliable, leading-edge, quality products, and services that are customer-centric, market-driven, and value-added.

To ensure sustainable competitive advantages through core capabilities, the research and development group at eXI regularly monitors the development of new RFID technology offerings and assesses their disruptive potential and applications. Since year 2000, the firm has participated regularly in industry associations and groups working to establish wireless communication protocols relating to various standards for RFID such as Bluetooth, ZigBee, IEEE802.15.4, Ultra-wide band, and others. Furthermore, eXI has committed to a 3-year partnership agreement commencing during the second half of 2005 with the University of British Columbia and the Canadian Federal Government to support research of ultra-wide band RFID technology. Hence, efforts to ensure sustainable competitive advantages through core competences are continuous and diligently managed.

Having developed the competitive capabilities, the ongoing challenge for eXI is to sustain them to the extent that they will continue to provide a competitive advantage. The requirement for renewing these competitive capabilities depends upon their relative newness. For example, lower power design competences that have developed for almost a decade may require renewal based upon scanning the environment and incorporating newer tag technologies, such as those discussed in section 2.4.1. However, capabilities in intelligent middleware design may require more emphasis upon developing these competences internally since acquiring them may not be possible given the relative newness of the capabilities to the RFID industry. The rapid consolidation ongoing within the RFID industry not only increases the chances of the new partnerships and companies surpassing the existing capabilities of eXI, but also stresses the importance for eXI to quickly continue to renew or recreate its competitive advantages originating from intangible resources.

Regardless of whether competitive capabilities are renewed or developed via internal or external resources, the challenge is to sustain them within an increasingly competitive industry. Hence in order to sustain the competitive advantage through existing competences, systems that monitor the environment must be developed. The main reason for loss of competitive advantage results from four types of change (Devinney, 1997, p. 4):

1. Competitor-induced change resulting from new products, services, or technologies;
2. Environment-induced change resulting from demographic changes or random events;
3. Evolutionary or gradual erosion of competitive advantages;
4. Spontaneous erosion of competitive advantages.

These types of changes constitute the main areas of risk regarding the potential jeopardizing of competitive capabilities, so the system for monitoring these capabilities must manage these risks and encourage renewal of core competences. Moreover, the system must also leverage the critical thinking or core competences that underpin the competitive capabilities. O'Drisco, Carson, and Gilmore (2001, p. 86) argue that this competence management system requires four key elements in order to accomplish this:

1. Discovery-driven innovation which allows the firm to test new technologies, markets, and products, and subsequently assess whether new competences are being developed;
2. Market orientation which encourages all facets of the firm to not only adopt a continual outward-looking perspective to assess market needs and trends, but also disseminate market information and requirements throughout the entire organization;
3. Strategic alignment between the various operational facets within the organization to set the context for competence development and support across the firm;
4. Knowledge management to enable codification and diffusion to foster not only the ongoing application and improvement of existing competences, but also the continual development of new capabilities.

Hence, even though the existing competitive capabilities and intangible resources for eXI originate from the R&D department, all aspects of the organization are required to achieve the potential benefits. Furthermore, as core competences change and develop to address new markets and requirements, the various supportive components of the organization will also be required to

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evolve in order to transform the resultant competitive capabilities into realizable business benefits. So each of the various operational facets must be part of the competence management system to not only support existing intangible resources, but also develop new ones.

Having identified the core competences at eXI and the resulting competitive advantages that can be used to address the Containers market, overall organizational resources are now analyzed in the context of being enabling resources that transform the firm's competitive capabilities into competitive product offerings within eXI's current markets. Each of the identified resources is analyzed in terms of current capabilities and potential changes that may be required to address its new markets.

4.2 Organizational Resources

The intangible assets discussed so far refer to those resources that provide competitive advantage. Additional resources are required to support these assets, transform them into outputs, and drive these outputs into the marketplace. Such resources enable the competitive advantage to be realized. These enabling capabilities are required, but are insufficient by themselves to competitively differentiate the company's offering (Leonard, 1998, p. 4). For eXI specifically, these enabling competences refer to the following resources: R&D, supply chain, sales and marketing channels, customer support, and business development. Significant challenges will be posed with regard to management of each of these competences as the firm moves into new markets. In order for eXI to successfully address these new markets, changes in existing management competences will be required. These changes are now discussed for each of the enabling resources, and followed by a discussion on the implications of organizational change.

4.2.1 Research and Development

The intangible resources previously discussed originate from the R&D department, so eXI's competitive capabilities are strongly rooted in this facet of the organization. In order for

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eXI to preserve competitive advantage and strengthen these capabilities, R&D efforts are continuously directed toward this endeavour as discussed in the previous section. R&D personnel currently spend an estimated average of 30% of their time on post-purchase customization and customer support for their RFID system deployments – the remaining 70% of the time is spent on ongoing projects. With resources already stretched, further extension or adapting of R&D capabilities for new markets will require additional management resources.

The current number of R&D personnel is about 12, all of whom are managed by the Director of R&D. While addition of another 2 or 3 people would not necessarily require a change in management structure, increases beyond this number may require alternate management capabilities relating to middle management skills such as hardware and software management. As the number of projects increases, formalized project management skills would also be necessary. With appropriate management in place, synergies and common development platforms, and product development protocols could be developed. The director of R&D could then be more focused in a leadership and strategic role, as opposed to that of strictly managing an increased number of people. If projects are required to be outsourced, then further skills would be required with R&D relating to external vendor management, contract management, negotiations, and management of potential synergies.

4.2.2 Supply Chain

Supply chain management at eXI consists of managing component vendors, third-party suppliers, manufacturers, and production facilities. eXI currently has one manager and 3 assistants overseeing the supply chain. Incremental changes to any of these supply chain elements, such as a small increase in the number of component vendors, will not result in the need for additional management capabilities. However, as eXI enters new markets, the supply

chain will be required to support an increased number of products, technologies, vendors, and manufacturers.

To support this increase, middle managers will be required to oversee various elements of the supply chain such as component vendors, suppliers, brokers, and production facilities. Experienced managers would be required with respect to purchasing, negotiations, and manufacturing. In addition, supply chain channel managers may be required if a new product requires new component vendors and manufacturers. For example, the Verichip passive tag utilizes technologies and production procedures that are new to eXI, and may require a dedicated supply chain manager to oversee the channel.

4.2.3 Sales Force

Sales channel management at eXI comprises of managing about 150 sales and distribution partners – all of which are focused on the Healthcare markets. These sales channels are currently managed by about 5 people knowledgeable in sales channels and customers for healthcare applications. An increase in the number of sales and distribution partners for Healthcare markets will not require additional channel managers. However, additional channel managers would be required to oversee channels that develop for new markets.

Applications for the Verichip tag and the Containers market are likely to be very different than those for eXI's existing products. For example, the implantable tag is currently being used by some Mexican police officials (Greene, 2004, para. 1) for monitoring and security applications. Such new applications and technologies will involve very different sales channels and management expertise since almost all of eXI's sales management expertise is specific to providing solutions to medical facilities and industrial markets (for the HOUNDware products). Furthermore, the end customers in the Verichip and Containers markets will require different

servicing than those in existing Healthcare markets which will further determine the managerial requirements of the new sales channel.

4.2.4 Marketing

The marketing team at eXI consists of about 4 personnel. Unlike the Sales division which has developed channels into its healthcare and industrial markets, there are no established marketing channels into any markets. Marketing management at eXI has primarily consists of public relations, advertisements, new releases, and other efforts for image building. The marketing department has limited involvement in trade shows in general. Marketing efforts and outcomes are constrained by the limited resources available.

As eXI moves into the markets for Containers and Verichip, it will be required to develop marketing channels to gain product publicity because the markets to be addressed are new to the firm. Hence, the marketing management skills required will be very different in comparison to those that are currently utilized. For example, for the Containers market, the managerial skills needed relate to product management and involve the following: customer needs research, segmentation and positioning, product features and marketing strategies, market education and preparation, and identification of both market needs and opportunities for next generation products. Implementing these initiatives successfully will require thorough understanding and knowledge of the Containers market. Hence, resources will be required not only to acquire market knowledge and ensure that sufficient marketing management competences are in place, but also to make certain that marketing tasks can be performed satisfactorily.

4.2.5 Customer Support

Customer support entails providing technical support to dealer channels and internal sales staff to ensure that eXI's systems are installed and operational according to customer specifications. The customer support department consists of about 5 staff knowledgeable about

application of eXI technologies and products for healthcare applications. Additional customer support management competences and resources would be required in order to address the Verichip and Containers markets.

Verichip applications entail implanting the passive RFID tag underneath the skin surface of the user. Hence, the operational environment for implantable tags and corresponding readers is very different than that of typical of eXI applications. Therefore the RFID system would be subject to environmental challenges and issues that are yet to be experienced by eXI customer support. Issues new to eXI will also result from applications in the Containers market since the operational environment consists of metal, machinery, and other factors, such as outdoor weather conditions, that would challenge the successful operation of the RFID system.

Hence, new applications, products, and markets will require additional management competences for customer support at eXI. Management competences required for customer support relate to experience and knowledge regarding RFID applications in subdermal or industrial environments. In addition, a knowledge management system would need to be developed so information could be stored and referenced. Given the relative newness of RFID applications for subdermal and Containers applications, such information could be challenging to obtain.

Customer support management would also entail importing knowledge from product developers. This would entail technical understanding of the new product offering in terms of function, use, and field application. Furthermore, new trouble-shooting skills would be required to address issues that may arise regarding the implementation that are specific to the technology utilized.

It is important to note that customer support, product integration, and standardization of functionality will be key features, or critical success factors, in successful adoption of eXI's value

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proposition in the Containers and Verichip markets. Hence, it will be crucial for customer support to be well-versed in helping the end customers attain these objectives.

4.2.6 Business Development

Existing business development initiatives at eXI relate to the leveraging of existing competences and capabilities to adjacent or overlapping market segments. Hence, the product or market evolution philosophy is based on incremental adaptation of existing competences to provide leverage. In order for eXI to address the Containers and Verichip markets, business development management competences that can leverage existing competences and capabilities to a larger degree will be required.

Management competences are required to establish partnerships or strategic initiatives to strengthen core capabilities to address completely new markets and product offerings. Such competences are critical success factors given the increasing consolidation in the RFID industry today. As such, thorough understanding of the sources of the core capabilities of both firms will be required in order to determine how they can best be leveraged to create new opportunity for the firm. Furthermore, a technical understanding of the core competences and competitive capabilities will also be required in order to determine the extent to which synergies can be created or new markets can be served through partnering with external resources. So management competences will also require a deepened technical understanding of the competitive capability and core competency that not only adds genuine value to the firm, but also can potentially add value to the partnership.

4.2.7 Implications of Organizational Change

eXI's current business model internally integrates R&D, marketing, and business development. Sales and various levels of customer support are internally integrated and also outsourced through networks of channel partners. Manufacturing is completely outsourced with

product verification and final assembly performed in-house. With this business model, each business unit of eXI operations works with particular types of customers. Hence, new management skills will be required for any changes giving rise to new business unit processes and new customers being served by these processes. With the appropriate management skills in place, new market opportunities or competitive capabilities can be developed from core competences since the resultant product or service offering can then be enabled throughout the firm and thereby support the development of these new skills.

For each of the enabling capabilities, eXI must determine whether the change in resources required should be developed internally, through education and training, or acquired externally, through strategic partnerships, or a combination of both. This decision would affect the company's internal structure with regards to managing and implementing all the enabling competences with respect to changes required. In turn, the nature of the internal resources and management competences required to facilitate the change would vary depending upon the extent to which the necessary resources are integrated internally. Higher degree of internal resource integration would require stronger management skills pertaining to internal training, resource management, and importation of knowledge. Higher degree of external outsourcing of resources would require stronger management skills in managing consultants, and formalizing and controlling external partnerships.

4.3 External Resources

These resources relate to current sources of information, processes, finance, or other assets that are external to the firm. These sources stem from relations with Agility Healthcare Solutions and Applied Digital Solutions that are unique to eXI. The experience, markets, product offerings, and other assets associated with these companies present potential opportunities for eXI

to partner with them in efforts to develop an appropriate technological platform upon which to address the Containers market.

4.3.1 Applied Digital Solutions

While eXI has experienced 10 consecutive profitable quarters, it has lacked adequate funding to pursue a number of product development efforts. During attempts to raise external funding in 2004, eXI negotiated an acquisition by ADS that is expected to be completed in April 2005. According to discussions with ADS, the organization is expected to inject funding into eXI after the acquisition is complete. Hence, ADS will be a critical source for eXI funding in the immediate future.

The limited funding available to date for eXI has restricted the resources which it has been able to allocate toward sales and marketing efforts for its existing product lines. These resources have been limited in terms of both finance and manpower. ADS is expected to contribute toward overcoming this limitation in terms of financing and marketing resources. ADS has a very strong marketing resource and is expected to utilize it in the promotion of the product offerings of eXI.

ADS currently consists of a number of subsidiary firms (Applied Digital Solutions, 2004, pp. 2-4) that offer RFID and other wireless technologies as platforms for their product offerings:

1. Digital Angel Corporation (DAC) provides product offerings in all major components of a modern livestock tracking system such as RFID tags, RFID readers, and software database tools for system integration;
2. OuterLink Corporation (OC), owned by DAC, manufactures and markets a suite of satellite-based tracking systems, operates a mobile satellite-data communications service, and supplies tracking software systems for tracking and messaging. OC offers tracking solutions for cargo trucks, industrial vehicles, helicopters, small aircraft, and cargo ships;
3. VeriChip Corporation (VC) markets a complete line of Radio Frequency Identification (RFID) Devices that can be used in a variety of security, financial, emergency identification, and other applications. VC is known for developing the world's only implantable passive tag;

4. Computer Equity Corporation (GTI), a provider of telecommunications solutions to the Federal Government, designs, deploys, provides and maintains voice, data, video and legacy telecommunication systems and networks nationwide;

5. InfoTech USA Inc. (ITU) provides information technology consulting, networking, procurement, deployment, integration, migration and security services and solutions.

Given the wide range of wireless technology offerings and services offered in the ADS subsidiaries, there are potential synergies for eXI. This portfolio of wireless technology offerings spans from RFID tags and readers to satellite communications to consulting and solutions. Hence, completion of the acquisition of eXI will effectively broaden the firm's network of potential partners, technologies, and service offerings. The array of product offerings of ADS through its subsidiaries offers the potential for end-to-end applications for eXI. For example, eXI could incorporate satellite communication protocols and infrastructures from OC to broaden the effective coverage area of its systems.

4.3.2 Agility Healthcare Solutions

In January 2005, eXI entered into an agreement to incorporate its tags, infrastructure, and software into the workflow and resource management solutions for healthcare facilities offered by Agility Healthcare Solutions (AHS). AHS management solutions will be "Powered by eXI" by utilizing the e-Tegra technology platform, and will also utilize the Assetrac software platform of eXI for tracking mobile assets in medical facilities (eXI Wireless, 2005, para. 4).

AHS is a subsidiary of TrenStar Incorporated. TrenStar offers complete solutions that combine asset acquisition, tracking technology and management services, and focuses on using RFID for tracking product containers in the following industries: brewing, synthetic rubber, chemical, food, and air cargo. TrenStar's business model for containers tracking is premised on a pay-per-use basis. TrenStar provides the containers for any of the prior-mentioned industries and also tracks them using its logistics management software. Effectively, TrenStar integrates into the given company's supply chain and manages the logistics. The status and location of a given

order can then be determined by accessing TrenStar's web-based reports. TrenStar also offers solutions for tracking mobile assets in the Healthcare industry through its AHS subsidiary.

Through its experience, TrenStar has already tackled some of the problems of deploying RFID in challenging environments such as tagging metal containers filled with liquids. Both metal and liquids can pose problems in terms of interference and distortion of RFID signals. Given the range of industry experience of TrenStar in tracking a variety of containers in heavy and industrial environments, there may be possible opportunities for synergies for eXI to leverage into the Containers tracking market.

4.3.3 Implications of External Resources

It is evident that the resources and experience of ADS and TrenStar promise some degree of opportunity for eXI to enter the Containers market in terms of partnerships and resources. However, these resources may not be easy to access given that the working relationships between these firms and eXI are still in the infancy stages. In this regard, the initial relationships and outcomes are yet to be proven, so the feasibility of establishing extended relationships, given that existing relationships are yet to be fully developed, remains to be determined.

Regardless of whether initial or extended relationships are developed, the competitive advantage resulting from the product or service offering will be a direct result of the extent to which the competences of both companies are combined. A proposition of highest value would probably result by finding an innovative way to combine the intangible assets of both organizations to further produce core capabilities that are truly unique and exclusive to the partnership. The extent to which this can be accomplished would critically depend upon the manner in which the relationship and assets are managed. This in turn gives rise to considerations concerning strategic management of intellectual property and rights ownership.

The assets of both parties should be managed in such a way so as to give rise to the development of a truly unique value proposition.

The management skills required to jointly manage these assets and potential synergies will also be a function of how quickly the relationship needs to be solidified and defined to address the market opportunity. Hence, that which is crucial will determine the management capabilities required to solidify the partnership. If the market opportunity is over a longer-term period then the capabilities and technologies from both firms can be merged over time. However, if the market opportunity is immediate then the capabilities and technologies will need to be merged very quickly. In either event, the management skills required to develop the partnership would be very different in these two cases, so new management capabilities may need to be acquired if necessary.

Regardless of the feasibility of developing partnerships with TrenStar or the ADS companies, it is important to note that the consolidation trend within the RFID market is fast emerging as a requirement to not only enter new markets, but also compete effectively in existing markets. As such, for a relatively small RFID company like eXI, consolidation then becomes an enabling requirement to compete successfully within the RFID industry. This applies even more so when firms are considering entering the Containers market or other large markets consisting of large powerful players. So regardless of whether the resources and partnerships discussed in this section are realizable, it is important for eXI to continually seek out new potential resources to which it can turn in order to renew and advance its capabilities to successfully sustain and improve its competitive position.

4.4   Summary of Unique Competences and Resources

eXI has cultivated RFID system development skills for the past 20 years, and is one of the pioneers in the RFID industry. Even though these skills have been developed while

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addressing the Healthcare market, they have resulted in core competences relating to the general application of RFID technologies with regard to low power design and intelligent middleware development. These capabilities are a result of eXI's abilities to customize products for the targeted market, and thereby demonstrate sensitivity to market conditions and requirements.

However, in today's RFID marketplace involving rapid consolidation, these existing competitive advantages will need to be continually renewed, while new ones are developed through the cultivation of new and unique competences. The relative speed with which competences have been developed and nurtured at eXI would also need to increase given the additional resources available for competitors in consolidated partnerships. Since all facets of the firm enable and support the realization of the outputs of the core capabilities, establishment of a company-wide competence management system is required to monitor the firm's external environment with respect to change. Such systems will help manage risk, renew existing competences and support structures, and develop new enabling capabilities across the firm. The enabling capabilities can be realized to the extent that the required management competences are in place to enable them. As long as the appropriate management structure is implemented, the new capabilities will effectively change business process model of the firm.

The new model will need to account for the fact that new business processes will serve a different type of customer, so additional management skills and resources will be necessary to manage the changes of internal processes required to service this new customer. The degree to which external resources will be utilized will also affect the type of management skills required. Although eXI has potential access to some external resources, the extent to which future relationships are possible remain to be determined depending upon how existing relationships develop. The types of resources required will be dependent upon the window of the opportunity. Shorter time window opportunities require higher levels of experience and deeper management

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skills, compared to longer term opportunities that can be addressed through gradual deepening of

expertise and management skills.

Having overviewed competences and resources available to the firm, various options will

now be discussed concerning the potential choices of how eXI can enter the Containers market.

5 Addressing the Containers Market

The purpose of this chapter is to overview the potential entry strategies for eXI with regards to the Containers market. The strategies and details discussed have emerged from combining the analyses of the RFID industry, Containers market, and competences and resources of eXI; hence, these options are based upon feasibility. That is, these options have been based upon the unique resources and competences that eXI can currently access to fulfill its desired strategy of entering the Containers market. The external resources are mainly in the form of potential partnerships with companies that are connected not only to eXI, but also to the Containers market. By integrating the core competences and competitive capabilities of both organizations, a value-added product offering could be developed for the containers tracking and security.

This chapter begins by discussing each of the potential go-to-market strategies, and concludes by discussing the important considerations that must be taken into account to choose the most viable option. The appropriate option is then chosen and further discussed in the next chapter.

5.1 Option 1: Develop a Solution Utilizing Resources of Applied Digital Solutions

As illustrated in the previous chapter, ADS owns a number of companies that would be sister companies to eXI after the acquisition. To address the Containers market, eXI could partner with OuterLink Corporation (OC) to provide a tracking solution for containers. Since OC already provides a satellite-based tracking solution for cargo trucks, eXI could develop a low-power active tag to communicate between the OC communications equipment installed in the

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truck, and the smart seal or even the environmental sensors mounted inside the container. This would result in a value-added system for OC. On the software side, eXI could integrate communications with its container tag into the OC software via its tag reader and e-Tegra middleware platform, and perhaps incorporate advanced decision-making capabilities through e-Tegra. For example, if a high temperature reading is detected inside the Container, the middleware could run a series of decision-based diagnostic tests on the container.

This solution would compete with implementation developed by the partnership between Savi and CMD discussed in section 3.4.4. The implementation challenge is that OC already provides the service of truck tracking, so an eXI solution would need to provide value-added functionality such as that previously described. Aside from a number of technical and relationship challenges associated with this initiative (for example, newness of relationships, or compatibilities of technologies), there are two issues in particular that would serve as enabling functions in order for eXI to compete within the Containers market with this particular implementation.

The first challenge would be to develop a low-power active tag solution that not only communicates with the onboard OC equipment, but also communicates with any environmental active tags inside the container or the smart seal on the container doors. The environmental tags could monitor conditions such as temperature, light, humidity, shock, or other factors to which the container cargo may be sensitive. Such information could then be monitored by the truck driver or central monitoring station. The eXI container tag would either function in the same way as a smart seal, such the Sentinel developed by Savi, or act as an interface between the smart tag and OC equipment. Unless eXI develops its own environmental sensors and smart seal, producing a low-power active container tag to satisfy the environmental requirements discussed here would entail providing the incentive for a company already producing active environmental tags, such as Savi for example, to participate in a joint development initiative.

The second challenge would be to develop a low-power active container tag that can function with the installed communications infrastructure in a given port, dock, or ship. Since applications for OC communications technology primarily entail tracking of trucks, vessels, and small aircraft, OC would need the motivation to expand its capability to a more granular level for containers tracking, and thereby penetrate the Containers market. Alternatively, eXI would need to work in partnership with one or more of the major players in the Containers market in order to develop a low-power active tag that can be utilized wherever the container may be within the transport value chain.

5.2 Option 2: Develop a Value-Added Solution with TrenStar

TrenStar, the parent company of Agility Healthcare Solutions, offers tracking solutions for containers used in air cargo transport and the transportation of beer, chemicals, food, and synthetic rubber. The company has already overcome many of the impediments associated with implementing RFID solutions in challenging environments containing liquids, metals, and other substances. eXI could potentially offer a value-added solution in association with TrenStar by way of its competitive capabilities. This would entail developing a lower power architecture for TrenStar to reduce the number of battery changes in any active tags that it may use. Similarly, the e-Link protocol could be used to determine container locations using the low power scheme. In addition, the e-Tegra middleware platform could be used to expand the number of different types of tags that could be utilized, in addition to offering decision-based processing capability.

Similar to the previous option, eXI's involvement with TrenStar would need to result in a value-added solution in order for TrenStar to enter a joint development initiative with eXI. Although TrenStar offers tracking solutions for a number of different product containers, the particular solution of interest to eXI would be that of air cargo containers since solutions developed for this particular application could potentially be leveraged into the Containers

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market. Therefore, this particular option would partially serve as a research and development stage for eXI to help determine how it could best use its competences to leverage into the Containers market.

5.3 Option 3: Develop a Closed-Loop Container Tracking Application using Assetrac

A closed-loop container tracking system based on eXI's Assetrac system could be modified (as necessary after adequate testing) to work in a container environment such as a port or dock. This would be similar to the Aeroscout application discussed in section 3.4.6 in that the eXI active tags would be temporarily placed on containers that are incoming to the given yard or dock. The tag would then be removed when the given container is outbound. This particular option may be the easiest and fastest way for eXI to enter the Containers market since it would be a modification of an existing eXI system. In order for this solution to prove successful, it would have to mitigate the existing challenges outlined in sections 2.5.4 and 3.3. However, existing RFID technologies and competences at eXI do not allow for Assetrac tags (or variations of them) to communicate with either environmental sensors within containers, or supply chain communication systems at other ports or docks.

To allow for the closed-loop tracking application to communicate with environmental sensors within the Container, eXI would need to partner with companies like Savi (as mentioned in Option 1). To allow for the container to be tracked from an offsite location, a number of different options could be considered. First, eXI could develop a variation of the HOUNDware Online software in order to allow for global tracking throughout the various elements in the transport value chain. This software would need to integrate with other software in the transport value chain as necessary. Second, eXI could partner with TrenStar to utilize its existing asset management infrastructure for global container tracking. The limitation here is that eXI's coverage and granularity of information would be confined to that of TrenStar's logistics

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infrastructure. In addition, eXI may end up competing with TrenStar in terms of deployment of active RFID tags. Third, eXI could partner with OC and utilize its existing communications infrastructure. A successful result from this particular choice would be a solution combining options 1 and 3.

5.4 Considerations for Choosing Options

In order to determine which of the options is the most viable, several considerations directly affecting the development of RFID products for the Containers market need to be evaluated. Evaluation of these considerations will determine the viability of each of the potential go-to-market strategies because these criteria critically underpin the feasibility of each of the options. First, the strength of the ties between eXI and the players in the Containers market should be taken into account. Second, the effects of the lack of standards within this market should be determined. Third, the potential for partnering with the dominant players in the Containers market needs to be ascertained. Each of these considerations is detailed below.

5.4.1 Potential Partnerships for eXI to Enter the Containers Market

The connection to TrenStar is not only relatively new, having been officially announced on February 8, 2005, but also indirect given that eXI is connected to AHS (eXI Wireless, 2005, para. 1) which is a spin-off from TrenStar. Furthermore, TrenStar has very limited involvement with cargo containers tracking given that its existing infrastructure has been developed for the purpose of tracking different types of containers for a small number of products. For cargo containers specifically, TrenStar tracks only smaller airborne containers.

Relationships with the subsidiary companies of ADS are also indirect. eXI has not worked with any of these companies before; furthermore, eXI has been informed that the only ADS company that it will be working with is Verichip. So after the acquisition of eXI by ADS

completes in April 2005, the potential for joint venture relationships between eXI and any of the other ADS companies remains to be determined.

Therefore, from a strategic point of view, eXI has ambiguous ties with those firms with whom it could potentially partner. Furthermore, relationships are non-existent with the major players of the Containers market and the ports, docks, and other storage facilities that are supporting the DHS mandate. Under ideal circumstances, eXI could partner with companies like Savi, GE, or any of the major players previously discussed in section 3.4 to undergo joint development initiatives to combine the core competences and competitive capabilities of each firm. However, from the point of view of feasibility, eXI does not have the resources, competences, or connections to execute such a strategy at this time. This suggests that unless eXI is able to establish relationships with the players in the Containers market, it may need to choose a strategy that would allow it to enter the Containers market unassisted.

5.4.2 Lack of Standards

As discussed in section 3.3, the lack of standards within the Containers market is the predominant factor affecting widespread uptake of RFID technology for containers tracking and security. This is reflected by way of multiple products and protocols, high costs of adoption and deployment, incompatibilities among different implementations, and lack of apparent ROI. While companies such as GE have already testified to applying efforts and resources toward driving its technology and product offering to the point of standardization, it would be safe to assume that other major players such as Savi will more than likely do the same. Since the lack of standardization within the Containers market is such an overwhelming determinate hindering adoption of RFID technologies within the Containers market, resolution of this issue is simply a matter of time.

The consequence of this situation is that any company choosing to enter the Containers market at this time faces the risk of its market offering being rendered obsolete at the time standards are decided upon or legislated. This applies irrespective of whether the market offering is either a partial or complete solution for containers tracking and security applications. The implication is that a relatively small firm like eXI faces a high technology and investment risk by offering a solution for the Containers market at this time. The safest option to choose to mitigate the risks posed by the lack of standardization within the Containers market at this time is option 3 – developing a closed loop system that confines the benefits of the RFID implementation to the given site.

5.4.3 Partnering with Existing Players in the Containers Market

The initiatives driving forward the adoption of RFID for containers tracking and security such as OSC, C-TPAT, C-TPAT Plus, CSI, and SST, are responsible for handling the vast majority of the world's container shipments. As previously mentioned, members of the SST alone are responsible for over 80% of global container shipments. As such, the technology providers (Savi, GE, and others) for RFID containers tracking and security are deeply entrenched in this market and will be very difficult for an inexperienced and relatively small firm like eXI to compete against. Furthermore, the lack of supply chain RFID technologies and experience of eXI would make a partnership with a major player like Savi or GE very challenging to obtain. In addition, there is no immediate way for eXI to demonstrate how its capabilities, competences, or technologies could be of justifiable value to the Containers market given its existing competences versus the competences and nature of the players and products that currently exist in this space.

In summary while any of these three options could potentially serve as a launchpad for eXI to prove its potential competences within the Containers market, the implementation risk inevitably surfaces from the existing lack of standards. In other words, developing any kind of

open-loop supply chain solution for the Containers market at this time will unavoidably be subject to the standardization risk. Hence, the only option at this time that would not be exposed to the standardization risk is option 3, since it would be closed loop solution (confined to a given deployment site). Option 3 could then potentially serve as a proof of technology and competence for potential partnerships and customers within the Containers market.

5.5 Choosing an Option

The three options presented are based on the feasibility of existing resources, competences, and capabilities that have been identified in chapter 4. In all three options, eXI would be required to incorporate its core competences and competitive capabilities into the product offering.

As discussed in chapter 3, the DHS has mandated that all containers inbound to the United States be equipped with a security seal by September 2005, so the security aspect of containers is the most significant driver of the adoption of smart seal technologies. Having established this regulatory requirement as the primary driving factor behind adoption of smart seals, the issue now arises as to how eXI can best take advantage of this market driver. In this regard, options 1 and 2 will be driven by the DHS mandate. Option 3 would not be directly driven by the DHS mandate because the closed-loop system would serve to function more as a tracking system, as opposed to a security system, unless of course the Assetrac tags are modified to function as smart seals.

Given the existing ambiguity associated with the newness of eXI's network of potential partnerships, it is difficult at this time to make an assessment as to the feasibility of any of the potential partnerships. Furthermore, eXI does not have any strong ties or partnerships with any firms developing and selling products or services for the Containers market. Hence, option 3 is

the alternative that is least dependent upon partnerships in terms of developing the initial closed system for a localized deployment of containers tracking and security.

The lack of standards in the Containers market poses significant development and technological risks. For option 1, the eXI container tag may no longer function with the smart seal or environmental sensors after standardization of communication protocols. For option 2, standardization may result in the eXI being unable to leverage its solution into the Containers market. For option 3, the localized deployment would be affected to the extent that the chosen standards would render the eXI containers tracking system incompatible with respect to integration with other solutions for an expanded product offering. However, this could be rectified for all the options by way of implementing the standardized communications protocol within the existing system, as opposed to designing a completely new system to adhere to the standards.

The lack of relationships with existing players in the Containers market would pose significant challenges for option 1 given that the value-added portion of the eXI solutions could entail not only communicating with smart seals and environmental sensors developed by existing players, but also transmitting information to offsite locations using communication infrastructures developed by current players. For option 2, the ability to leverage the eXI solution for TrenStar will be hindered without relationships with existing players. For option 3, the localized deployment would not be affected by the lack of relationships with existing players given that the implemented solution would be a variation of the existing Assetrac solution.

The risks associated with each of the options are summarized in Table 2.

Table 2   Summary of Risks and Options

	1 – Low risk 2 – Medium risk 3 – High risk			
	Existing Partnerships	Standards	Partnerships with Major Players	**TOTAL RISK**
Option 1	2 – 3	3	3	**8 – 9**
Option 2	2 – 3	3	3	**8 – 9**
Option 3	1	3	1	**5**

It is apparent that there are a number of considerations and factors affecting how eXI can best enter the Containers market. In order to minimize the risks associated with the limitations of partnerships, option 3 is the appropriate recommendation for eXI. Since this implementation would be based upon the existing Assetrac system, eXI could utilize its core competences and competitive capabilities when developing this solution for the Containers market. Furthermore, option 3 could serve as a platform to prove the system and technology for container security and tracking. After the successful implementation, eXI would then have a stronger foundation and proven implementation upon which to develop partnerships with existing players and customers in the Containers market. Once standards have been established within the industry, eXI could then leverage this platform by extending its functionality through joint ventures to include monitoring of environmental sensors, in addition to potentially implementing global communication and containers tracking.

It should be noted, however, that if eXI wants its container tags to communicate with other systems (or else, if eXI wants third party tags to communicate with its system) then eventual industry standardization would require that the communications protocols for the tags, readers, and infrastructure be changed to according to the definitive industry standard. Given the current impact of the lack of standards, standardization is practically inevitable, so the question

arises as to whether this is the right time to even enter the Containers market. Details concerning

this and additional considerations are further discussed in the next chapter.

6 Implementing the Recommendation

Although option 3, developing a variation of Assetrac, has been recommended for eXI, there are numerous challenges associated with implementing any of the suggested ways in which eXi could enter the Containers market. This chapter discusses these considerations and the impact on the extent to which eXI can successfully compete within the Containers market. The challenges discussed in this chapter can be related to each of the options in varying degrees.

This chapter begins by discussing the potential impact of standardization and consolidation on the market entry of eXI into the Containers market given the extreme strategic importance of standardization within a large and global market. Required changes for organizational resources are then overviewed because these are not insubstantial and will involve a great deal of management effort. Lastly, consideration is given to the value provided by eXi's current competencies, highlighting that management cannot afford to neglect to consider what it already possesses and how it can be best exploited to create value. The implications of the findings are then discussed in the last section in terms of how standardization, consolidation, and the resulting industry structure will impact the level of success attainable by leveraging internal competences and core capabilities.

6.1 Standardization

eXI has expressed an interest in the potential development of industry standards for the Containers market; however, it is not clear at this time how this can be achieved. As discussed in the preceding chapter, eXI not only has very weak ties to the Containers market, but also has limited credibility as a technology or systems provider in this segment. It is more than likely that

by the time eXI has developed a proven product or technology in this market, standards will have come into existence from the larger players, such as Savi or GE, given that these companies are already pushing their products and services as the industry standard.

Another factor limiting the amount of involvement that eXI could have in the development of standards in the Containers market is the ongoing consolidation within the Containers market and the RFID industry in general (as illustrated in section 2.4.6). Of particular relevance is that large players, such as Savi and GE, are consolidating with large companies such as CIMC, DOD and Unisys, as discussed in section 3.4. The products and services resulting from such partnerships significantly diminish the chances of smaller firms like eXI, with unique technologies, from even entering the Containers market, let alone setting the standards. Consolidation within the Containers market is therefore affecting the balance of power to such an extent that the ability to influence the development of standards is more important than the advantages of the technology itself. This situation plays to eXI's disadvantage being a small player with a core competence in technology.

6.2 Challenges for Organizational Resources

To implement option 3, eXI tags and readers would need to be developed to overcome the deployment challenges mentioned in section 3.3 related to tag/reader alignment, functionality in cold outdoor temperatures, and performance in a containerized or metal environment. This would entail eXI leveraging its existing core competences concerning product customization and overall sensitivity to market conditions and requirements. While eXI does have the competences to address these implementation challenges, these capabilities will need to be stretched to the extent that they can address the Containers market. This would be no small feat as discussed below regarding the number of areas in which competence would need to be developed.

Specifically, R&D would need to develop RFID tags and readers that can function in a rugged outdoor environment. Furthermore, a testing facility or actual container site would be required to test the RFID system. In order to avoid cannibalizing R&D efforts to sustain and improve the products and services for existing products and markets, additional management and R&D expertise would be required to oversee the Containers initiative and redesign and test the Assetrac system for the Containers market as discussed in section 4.2.1. This level of commitment would be critical to ensure that core competences can be appropriately leveraged into applications for the Containers market.

In order to ensure that the knowledge base supporting the core competences is fully leveraged into developing a solution for the Containers market, members of the Customer Support department will also be required to work with R&D group. This will not only allow for field application knowledge to be leveraged into the development and testing of the new system, but also allow for practical implementation knowledge of the new system to be acquired by the Customer Support team. A knowledge management and storage system would need to be developed and maintained for this endeavour.

While the developed product may not require management of a new supply chain, new supply chain management skills would be required as the developed product is integrated into offerings arising from future partnerships. The formation of consolidated partnerships within the Containers market has literally become an enabling requirement to successfully penetrate this segment once a potential technological or service-based launchpad has been developed by a given firm. Depending upon how products and services are integrated, the supply chain, and therefore the management of it, may require significant change. For example, if the low power benefits of the eXI container tag end up being integrated into the Savi smart seal, then eXI may need to either integrate its supply chain for container tags with that of Savi. In addition, as eXI either

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utilizes technologies from vendors that are new to the firm, or develops new products, the supply chain would modification or expansion.

Competences in management of new sales channels would also be required to address the Containers market given that channels that currently exist are specific to Healthcare markets. Customers in the Containers markets may also have different servicing requirements, so appropriate value-added resellers and service providers would need to be incorporated into the new sales channels.

As discussed in section 4.2.4, required marketing management skills will be very different in comparison to those that currently exist in order to address the Containers market. New responsibilities would include performing customer research, market segmentation and positioning, product feature planning, market preparation, and future product planning. Hence, the management skills and competences required would relate to maximizing market acceptance and customer value, as opposed to promotion of existing products. Furthermore, new marketing channels would need to be developed for eXI to enter the Containers market.

In summary a number of competence development initiatives would therefore need to accompany the decision to enter the containers market. These would require allocation of additional resources and management efforts and, of course, would need to be performed successfully for eXI, in turn, to be successful in the Containers market.

6.3 Value Creation through Core Competences

In order for eXI to create and sustain competitive advantage in the Containers market, it must leverage that which cannot be easily imitated – competitive capabilities that have been developed through core competences. For this reason, it is important to validate the degree to which competitive advantage can be achieved within the Containers market on the basis of that

which eXI currently possesses that is difficult to imitate. The extent to which eXI can create value is relative to how the competitive capabilities of eXI measure up against those of the competitors. Given that eXI's core competence is technology/product based, it must evaluate whether those features of a potential product offering for the Containers market are derived from competitive capabilities which will truly provide customer value beyond that which is currently provided or could be provided through competitor offerings. This evaluation should look at the viability of utilizing competitive capabilities in miniature tag design, low power design, tamper-proof patents, and e-Tegra middleware development.

As discussed in section 4.1.1.1, eXI has built up 9 years of knowledge regarding the miniaturization of active RFID tags. It remains to be determined whether attributes relating to reduced form factors, or unobtrusive solutions, would be of value to customers in the Containers markets given the relatively large size of cargo containers. In addition, the efficiency of the eLink low power algorithm starts to decrease when processing information relating to more than 400 tags, so this competitive capability may not suffice for locations where many containers are on site. Moreover, patents surrounding the tamper-sensing capabilities of eXI active tags may not prove to be of added-value in the Containers market. For example, the patented-skin sensor will not function on the metal surface of a container.

Furthermore, key features in the e-Tegra middleware platform that would provide competitive advantage and customer value such as the ability to interface with a wide variety of tags, readers, and communication protocols may not be required once standardization issues within the Containers market have been addressed. In addition, unique value propositions, such as the decision-making capability of the e-Tegra middleware platform, may not be valued given the level of sophistication and integration that companies like Unisys have achieved (discussed in section 3.4.3) in the Containers market with regard to IT systems that underpin RFID

implementations worldwide throughout a number of industries including the supply chain of the DOD.

In conclusion, eXI needs to think seriously about whether its current competencies can be advantageously leveraged to enter the Containers market. In addition, considerable thought should be given as to how these competences can be best leveraged into other markets not considered in this paper.

6.4 Considerations for Entering the Containers Market

It is evident from the discussion in this chapter that there are a number of challenges facing eXI with regard to entering the Containers market. This section summarises these and reaches an overall conclusion about the fit between the Containers market and eXI.

Given, the wait-and-see attitude (discussed in section 3.3) that is becoming increasingly prevalent within the Containers market, the need for standardization has been recognized. As a result, major players such as GE are striving to have their product and service offerings adopted as the industry standard. This has given rise to the notion that standards and power are more important than technology itself in order to succeed in the Containers market. Consequently, the trend within the Containers market (and the RFID industry in general) is that of consolidation. In light of this, even the major players such as Savi and GE are consolidating by way of partnerships and integrated product offerings with other entities such as CIMC, Unisys, and the DOD. Hence, there is an increased emphasis on integrated product offerings by partnerships of players that are well entrenched in the application of RFID technologies for supply chain applications.

This trend towards consolidation creates a very challenging environment for smaller firms like eXI to enter the Containers market or even partner with existing players in this space. In addition, eXI has competitive capabilities that are rooted in the development of the technology

itself. This may not provide sufficient leverage into the Containers market given the recent trends in this segment toward standardization and consolidation.

If eXI chooses to enter the Containers market before standards are decided, it runs the risk of technological incompatibility after standardization has occurred. Even if ramifications of this risk are either avoided or rectified after standardization, the risk then translates from standardization risk to adoption risk. The standards and consolidated partnerships will determine the industry structure that will more than likely be dominated by very few large players given that Savi is involved with the SST initiative that controls over 80% of global container shipments, and GE is partnered with the CIMC, the world's largest container manufacturer. Unless eXI is able to provide these dominant players with incentive to partner with the firm, the level of attainable success with the Containers market will be limited.

Furthermore, eXI will need to develop or acquire appropriate management competences across all facets of its organization in order to produce an offering for the Containers market that will prove its ability to create value. In addition, eXI will need to expand externally by way of channels relating to supply chain, sales, and marketing. However, this will not guarantee success given the lack of standards and ongoing consolidation within the Containers marketplace.

A further constraint on the level of success that eXI can attain within the Containers market is the extent to which eXI can utilize its current capabilities to achieve competitive advantage. Competitive capabilities giving rise to technological advantages such as miniature RFID tags, tamper-proof technologies, eLink protocol, and e-Tegra middleware, may need to be renewed on the basis that the competitive advantages gained from the capabilities may not be as valued in the Containers market as in the Healthcare markets of eXI. Renewal of these capabilities will take time and delay the entrance of eXI into the Containers market.

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To conclude, standardization and consolidation driven by large players are overriding the importance of technology resulting in far reaching implications for a small RFID firm like eXI looking to enter the Containers market. This implies not only that technological prowess will be insufficient to enter this segment, but also that small companies currently premised upon technological prowess will be doubly disadvantaged. Added to this significant management undertaking, eXI will also be required to acquire or develop additional management competences across all facets of the organization consuming resources in terms of money and effort in an attempt to enter a market in which success will be far from guaranteed.

7 Conclusion

The Containers market is notably attractive to any RFID player given its size and growth potential as discussed in section 3.1. The question for eXI is perhaps not whether it is attractive, but whether its attractiveness is too obvious. Such a highly attractive market is attracting many players and will likely continue to do so, especially large firms with a wider base of competences, resources, and influence than that of eXI. This situation, combined with eXI's major competences that are based upon technological prowess, creates a basis for competition and level of competition which eXI cannot easily match. Therefore, the conclusion is drawn that eXI should seriously consider the viability of addressing the Containers market in which the firm has limited management competences, domain expertise, development experience, credibility, and resources in comparison to those of the larger players that currently exist in this space.

This conclusion is based on the notion that the choice to enter new potential markets should take into account more than attractiveness in terms of size and growth potential. First, it should take into account how competitive the market will be and on what basis players will compete within that market. Second, viability in terms of the firm not only leveraging existing capabilities, but also building upon them in order to deepen the competitive advantage in both new and existing markets, needs to be considered. Third, even if the basis of competition can seemingly be accommodated by a combination of stretching current competencies and developing new ones, the key to success lies in being able to devote adequate resources to the increasing managerial complexity associated with the systematic upgrade of competences without compromising the capabilities required to serve existing markets. This managerial challenge can be easily underestimated.

To fully exploit the market potential of its competence base, as an alternative to the Containers market, eXI should look toward markets in which it can not only leverage and deepen this base, but also take an active and feasible role in the development of standards based on the advantages gained from its core competences and competitive capabilities that are rooted in technology. In this manner, consolidating with other players becomes feasible when appropriate to provide integrated solutions by combining complementary products into standardized offerings. These might be less obvious niche markets, or at least smaller markets, where eXI can dominate with its technology and its ability to cross the chasm with new technology without being too concerned about economies of scale and the resulting ruthless and rapid price reductions or standardization that can occur when competing with larger and more dominant players.

To rapidly exploit such markets as they become available, eXI must scan the environment constantly given the competitive and fast-paced dynamics of the RFID industry as a whole. The blurring of industry boundaries and trends discussed in sections 2.3 and 2.4 are key drivers governing the need for constant monitoring of the RFID environment in both existing and potential markets. Such driving factors need to be monitored constantly to not only evaluate the existing state and driving factors of a given market, but also determine the market structure, driving forces, and estimated level of attractiveness at the potential time of market entry and in the future.

Given the increased efforts required for this endeavour, a formal scanning group may need to be established. Scanning efforts should be focused on monitoring the four types of change discussed in section 4.1.3. To further enhance competitive insulation in increasingly crowded and competitive markets, a competence management system outlined in section 4.1.3 will be an enabling requirement to successfully compete in both current and potential markets.

Another factor influencing the ability of eXI to compete in existing and future markets is the acquisition of the firm by ADS. Since eXI will be taking on the Verichip name and be known as an "RFID for People" company, the image that ADS intends to create for eXI or Verichip could impact the markets that can be accessed since the new name and slogan of the firm will affect the perception and credibility of eXI in the RFID marketplace. In addition, the actual intentions of ADS for eXI may be unknown at this time. Furthermore, eXI will no longer have as much control over the use of its funds after the acquisition is official, thereby constraining its ability to openly choose its markets. Finally, the efforts required to integrate Verichip and eXI may be substantial and thereby present a challenge for eXI to compete in its existing segments, let alone participate in new markets.

In summary, eXI should choose its markets based upon the viability of being able to leverage its core competences to create value and competitive advantage while simultaneously being able to provide the increased managerial complexity to manage and develop competences required to succeed in both new and existing markets. The level of success that can be attained in this endeavour will be determined by firm's efforts to renew its core competences, scan the environment, and simultaneously manage not only the acquisition by ADS, but also the merger with Verichip and its products and markets. A large amount of planning, resources, and management effort will be required of eXI to manage this complexity suggesting that a more formal structure for planning and coordination may be required than that which currently exists.

APPENDIX – RFID Solutions Providers for the Containers Market

1. Accenture Ltd
2. Active Wave
3. Advanced Resources Corporation
4. Aeris.Net
5. Aether Systems Inc
6. Aether Wire & Location
7. Airgate Technologies
8. Alien Technology
9. Alliant Energy Corporation
10. Allset
11. AltoBridge
12. AT&T Wireless
13. Avery Dennison
14. Axcess Inc
15. BearingPoint
16. BridgePoint
17. BVSG
18. CACI International
19. CAEN SpA
20. Cellemetry
21. CGM Security Solutions
22. CHEP
23. China International Marine Containers
24. China Unicom Ltd
25. Cingular Wireless
26. CrossLink
27. Deister
28. Deloitte & Touche

29. DigiCore

30. EJ Brooks

31. Embarcadero Systems Corporation

32. EMS (Datalogic)

33. FreightDesk Technologies

34. General Atomics Aeronautical Systems

35. General Electric Corporation

36. Global ID

37. GlobalTrack

38. Hi-G-Tek

39. Hi-Tech Solutions

40. Hutchinson Whampoa

41. Hyundai Corporation

42. IBM Corporation

43. Inmarsat Ltd

44. Innovision

45. Intelsat

46. Intermec Technologies Corporation

47. Iridium Satellite LLC

48. JB Hunt

49. Lorantec Systems

50. LXE Inc

51. Manhattan Associates

52. Matrics

53. Microsoft Corporation

54. MobileAria Inc

55. Motient Corporation

56. Multispectral Solutions Inc

57. nAL Solutions

58. Navis

59. Navitag Technologies

60. Nextel Communications Inc

61. NTT DoCoMo

62. Omron Corporation

63. Oracle Corporation

64. Orange

65. Orbcomm Inc

66. PACECO

67. Panasonic

68. PAR Logistics Management Systems

69. Qinetiq

70. QUALCOMM Inc

71. RAE Systems

72. RF Code Inc

73. RFID Inc

74. Science Applications International Corporation

75. SAMSys

76. SAP Aktiengesellschaft

77. Savi Technology

78. Scemtec

79. SecTrack

80. SK Telecom

81. SkyBitz

82. Sprint PCS Corporation

83. Sun Microsystems Inc

84. Symbol Technologies Inc

85. Tagsys

86. Telus Corporation

87. Terion Inc

88. Textainer

89. Thales Telematics

90. T-Mobile

91. TransCore Inc

92. TrenStar

93. Tyden Seal Company

94. Unisys

95. Verizon Wireless

96. WhereNet Corporation

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