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If You Build It, They Will Come: EPC™ Forum Market Sizing Analysis

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Snowstorm Triggers Electronic Product Code™ (EPC™) Market Avalanche

CINCINNATI – The EPC™ Forum was conducted December 3, 4 and 5, 2002, during an unexpected Cincinnati snowstorm with more than 200 retailer, supplier, manufacturer and technology executives representing more than 85 different companies. According to one executive, the meeting was described as likely the single-most important retailer- and supplier-related event yet held in the new millennium. Paul Singer, CIO, Target Corporation, stated during the panel discussion, "I'm not sure if it will be in five years or 10 years, but we will look back on this event as a catalyst that accelerated the take-up of the EPC™."

What is the EPC™ and why such grandiose statements for an event that was conducted with such little fanfare? The EPC™ is a unique identifier, plain and simple. But it has the power to change the way the world works and lives like no other technology before it.

Based on research, survey information and input from pioneering companies, this paper provides insights on how big and in which direction this market may grow. The EPC™ market is new and big, like fresh powder on a mountainside. Be one of the first to make tracks and you'll be out in front of the avalanche, instead of under it.

Accenture Silent Commerce
www.accenture.com/SilentCommerce

Auto-ID technology has left the lab and is out in the real world so it's not a matter of if, but when. Will you be ready to take advantage of the opportunity? Accenture has a vision for Auto-ID and broader related technologies, called Silent Commerce. Silent Commerce creates unlimited new business opportunities by making objects intelligent and interactive. It is "silent" because communication and commerce can take place between objects such as cases of paper towels, dock doors and warehouse management systems. For several years, we have been exploring the business potential of these innovative technologies at Accenture Technology Labs' Silent Commerce Centers located in Chicago, Illinois; Palo Alto, California; Sophia Antipolis, France and the Accenture Institute for Strategic Change in Cambridge, Massachusetts.

We have built working business applications and industry prototypes. We host hands-on workshops where companies can explore near- and long-term business and industry implications. This year in conjunction with the Auto-ID Center, we've collaborated with retail, consumer goods and freight transportation industry leaders to bring you a series of white papers focused on this exciting new value-creation opportunity. Auto-ID technology is an innovation that will revolutionize your business as you know it today. We invite you to explore the possibilities. Read on!

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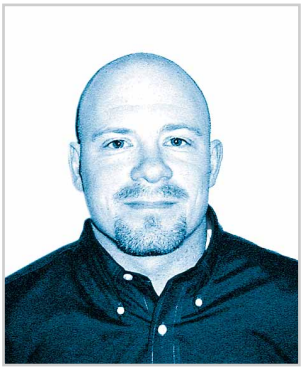
If You Build It, They Will Come: EPC™ Forum Market Sizing Analysis

Biographies

Joe Dunlap
Manager

Joe Dunlap is a Manager in Accenture's Supply Chain Management Service Line and is based in its Atlanta office. His areas of specialty include distribution operations design, warehouse management systems implementation and transportation management. Joe leads Accenture's Warehouse Management Systems Skill Group within the Supply Chain Management Service Line. He is also responsible for Accenture's relationship with several leading supply chain execution software providers. Before joining Accenture, Joe spent 10 years in numerous positions with United Parcel Service in a variety of areas, including industrial engineering, operations management, information technology and business development. Joe has served as Vice President and Secretary for the Atlanta Chapter of Warehousing Education Research Council (WERC). He has a Bachelor of Science in Business Administration, Management Information Systems degree from the Tennessee Technological University.



Greg Gilbert
Manager

Greg Gilbert is a Manager-Supply Chain Management in the North America Retail & Consumer industry group of Accenture. He specializes in applying Auto-ID technology solutions to the extended supply chains of retail companies, which has led to improved performance and reduced costs. Since joining Accenture in 1996, Greg has spent the majority of his career focused on business process reengineering, software application implementations, supply chain planning and systems execution. Greg received a Bachelor of Arts degree from the University of Alabama and a Master of Business Administration from the University of Alabama Manderson Graduate School.

Lyle Ginsburg
Partner

Lyle Ginsburg is the Managing Partner for Technology Innovation in Accenture's global Products Operating Group. With more than 20 years' experience identifying new technology trends and bringing them to market, Lyle is now focused on finding the value of Silent Commerce for Accenture clients in the retail, consumer goods, transportation, hospitality, pharmaceuticals, life sciences, automotive and industrial industries. He has a Computer Science degree from Northern Illinois University.

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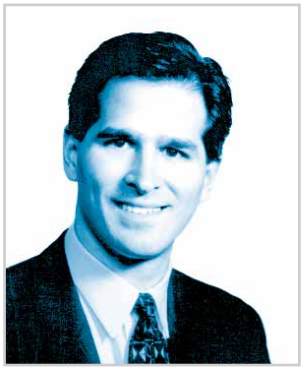
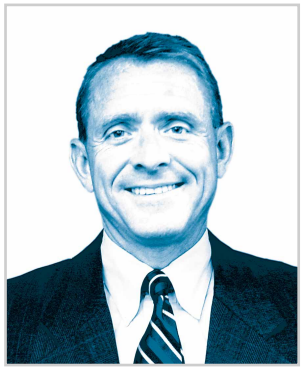
Biographies



Paul Schmidt
Senior Manager

Paul Schmidt is a Senior Manager in Accenture's Retail & Consumer Goods industry group with more than 13 years' experience delivering Supply Chain, Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP) solutions to global consumer goods manufacturers and retailers. He has worked with clients in program and project management roles during opportunity assessments, business process reengineering, technical architecture definition and application software evaluation, development and deployment. Recently, Paul served as the director of the Accenture Supply Chain Alliance Program with responsibility for identifying and managing Accenture's alliance partners across the entire spectrum of supply chain functions. Paul has a Bachelor of Business Administration from the University of Wisconsin-Whitewater.



Jeff Smith
Partner

Jeff Smith serves as the Managing Partner for Innovation in Accenture's Retail & Consumer Goods industry group. He is an internationally known specialist in technology innovation and Enterprise Resource Planning (ERP) solutions, speaking regularly to retail, manufacturer and other industry trade groups in the Americas, Europe and Asia. Over his 23-year career, Jeff has specialized in strategic planning, data modeling, design and development of value-creating technology solutions for large retail and consumer goods companies, with a focus on customer/supplier collaboration processes and systems. Clients include Sara Lee, Meijer, Novartis Consumer Health, Nestle, Ahold USA and Wegmans. Jeff currently leads a research team assisting the Auto-ID Center in developing business cases for the commercial application of new Electronic Product Code™/radio frequency identification technologies (EPC™/RFID) in the consumer industries. Jeff holds a Master of Business Administration in Organizational Behavior/Informational Systems and an AB in Economics from the University of Michigan at Ann Arbor.

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1. INTRODUCTION

Learn more about the EPC™ Forum at: www.epcforum.com/pages/1/index.htm

This paper highlights the market sizing information that was prepared and presented as part of the EPC™ Forum held in Cincinnati, Ohio on December 3, 4 and 5, 2002. The objectives of the EPC™ Forum were threefold:

- To obtain alignment among end-users of the EPC™ on common early applications of the technology.
- To communicate these requirements to the technology community so that it can build solutions to meet the greatest market demand.
- To accelerate EPC™ market availability and take-up.

Several different sources confirmed that the market for EPC™ technology will be significant with billions of dollars spent annually on products and services.

Based on our research, and input from the EPC™ Forum, the following are key considerations regarding what we believe to be the direction of the EPC™ market:

- Inventory management and out-of-stocks are the highest priority applications for Auto-ID.
- Pallet- and case-level tagging will be widespread in the next 12 to 24 months; the timing for item-level tagging will depend on product category economics and tag prices.
- Retailers expect broad usage 12 to 18 months sooner than manufacturers, across more categories and at lower levels (case and item level).
- End-users have high expectations of technology capabilities, including 100 percent reads and the ability to read each sub-unit when aggregated (i.e., read each individual case on a pallet of cases).
- End-users realize a "whole production solution" doesn't exist and that components will need to be combined from a variety of vendors.
- Standards are the key to enable interoperability between different vendors.
- EPC™ and Auto-ID technologies will create tremendous amounts of new data and information. Information sharing among trading partners will be required and essential to obtain the anticipated benefits.

2. ACKNOWLEDGMENTS

Accenture would like to acknowledge and thank the many companies, organizations and individuals whose insights proved invaluable to this paper, including members of the EPC™ Forum planning committee from Johnson & Johnson, Target Corporation, Wal-Mart Stores and especially Procter & Gamble for hosting the event. We also would like to thank all the forward-thinking individuals and companies who participated in the EPC™ Forum who are far too numerous to mention.

3. APPROACH

The overarching objective of the EPC™ Forum was to align end-users of Auto-ID technology to the five-to-six critical common requirements for broader deployment of Auto-ID solutions, and then communicate these to the technology community. Our approach to developing the market sizing included:

– Analysis of third-party research, as well as Accenture proprietary research and experience.

– A base level of understanding of Auto-ID and EPC™ technology was provided for EPC™ Forum attendees. The EPC™ Forum brought together more than 200 attendees representing more than 85 companies across a broad cross-section of industries. Although some of the participating companies are current sponsors of the Auto-ID Center, nearly half were not. The following information was provided to all attendees:

  – Pre-reading materials
  – Optional "EPC™ 101" educational session
  – Review of business cases identifying areas of opportunity
  – Review of pre-event survey results

– Breakout sessions at the EPC™ Forum were conducted with end-user company participants to:

  – Understand "current perceptions" of Auto-ID opportunities and challenges.
  – Discuss and gain consensus among participants on key areas within the supply chain where Auto-ID can have maximum impact (referred to as "application areas").
  – Select three high-priority application areas to discuss in more detail.
  – Identify the potential key operational and potential financial benefits that will drive adoption.
  – Identify key requirements for technology vendors.
  – Capture feedback and perceptions of the challenges and barriers of adoption for these application areas.
  – Obtain directional "intent" on scale and timing of Auto-ID investments.

The resulting information was summarized and presented to both end-user and technology companies in attendance at the EPC™ Forum on December 5, 2002. The information presented and associated analyses are included in the remainder of this white paper.

The following information DOES NOT represent the opinion of any particular company, nor does it suggest a commitment to buy or use any specific solution or application that may or may not meet the specifications published by the Auto-ID Center. Note also that the data from the survey and breakout sessions is not statistically significant and is only directional in nature.

4. FINDINGS

The purpose of the market sizing information is to provide insights to the technology community and help them in understanding the potential size of the rapidly emerging Auto-ID technology market. These findings may provide a set of data that could be used when preparing business plans for moving forward into product development and bringing new solutions to the marketplace. However, these findings should not be relied upon as the only source of information in any decision.

Accenture's assessment of the Auto-ID marketplace and its future potential was compiled from three sources: a macroeconomic view based on external, third-party analysis, the EPC™ Forum pre-event survey results and the feedback from end-user companies who participated in the breakout sessions. The findings describe the potential size of the marketplace and why it may be worthwhile for companies to be focusing effort, resources and executive attention on the Auto-ID market.

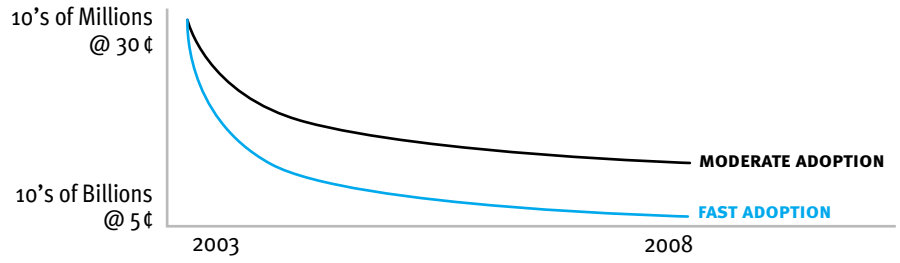
4.1. Analyst & Research Data

Recent research conducted by the Auto-ID Center illustrated in Figure 1 outlines the potential growth of Auto-ID technologies in the marketplace and potential spend directed toward it.

The variable costs for manufacturing tags are quite low. The fixed cost of developing the tags as products, however, is significant and must be recouped. Getting to critical mass to reach the break-even point and cover manufacturing capacity will require producing volumes into the hundreds of millions and billions. Only then will we see tag prices drop dramatically.

Figure 1: Kevin Ashton, Executive Director, Auto-ID Center, Presentation at Grocery Manufacturers of America (GMA) Greenbrier Conference, June 9, 2002.

THE IMPACT OF ADOPTION ON TAG COSTS



The $0.30 tag has already come and gone. Passive tags now exist in the $0.15-to-$0.20 range. The $.05 tag is considered the desired target state for a price point, but has yet to be achieved. It will take volumes in the billions to reach that state. Some are skeptical how quickly this will occur, but if the announcement by Gillette in January 2003 that they will purchase 500 million tags is any indication, it will happen sooner rather than later.

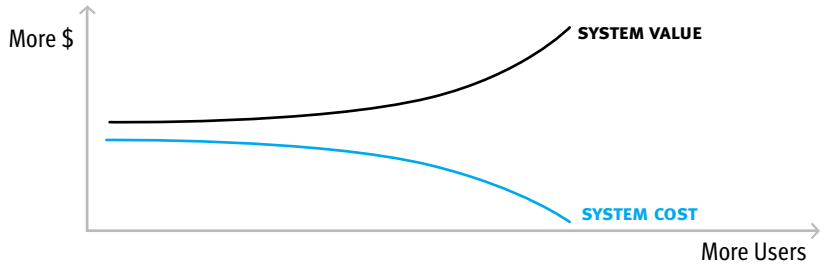
[1] "Breakthrough on 1-Cent RFID Tag," RFID Journal, December 2, 2002.

The fast adoption curve, a much more aggressive outlook, shows that it will be possible to drive below the $.05 tag within the next five years, depending on how fast the marketplace will adopt its use. Already, reports are surfacing of manufacturers developing technology that may make a $.01 tag possible at the end of this time horizon.[1]

In Figure 2, Auto-ID Center research points to a trend that the more the technologies proliferate, the greater the aggregate system value will be in terms of creating business value for all the various participants in the supply chain.

Figure 2: Kevin Ashton, Executive Director, Auto-ID Center, Presentation at Grocery Manufacturers of America (GMA) Greenbrier Conference, June 9, 2002.

THE IMPACT OF ADOPTION ON RETURN ON INVESTMENT



Simply stated, the greater the number of tags and readers that are used, the lower the incremental cost will be to implement an incremental application.

In the current economic climate, future IT budget projections are flat or slightly up at best. However, companies will continue to allocate budget toward advanced technologies, like Auto-ID, that demonstrate potential for both economic payback and strategic advantage.

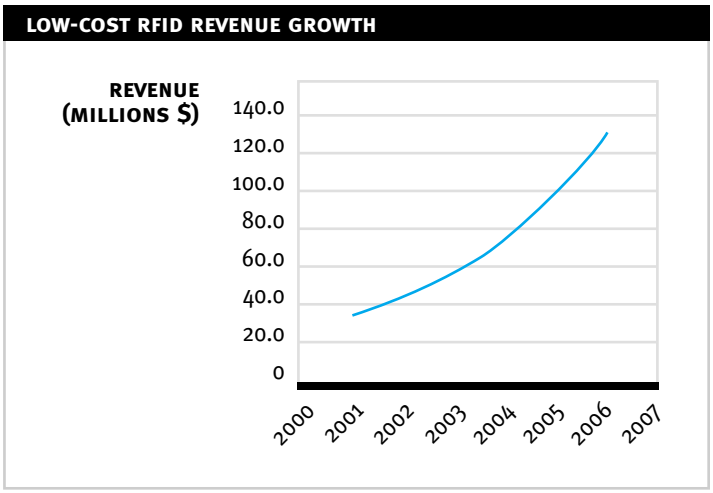
During the EPC™ Forum, one CIO in attendance described his situation in the following way:

"...many vendors and analysts come and talk to me. They always ask what direction my budgets are going – up, flat, or down. If I indicate down they tend to be discouraged and walk away. If they bothered to stay and ask a follow up question on what I'm doing with the budget I have, here's what I'd say... spending is clearly down on ERP since we're now in maintenance mode. However, spending is up on new and coming technologies like supply chain solutions and EPC™ and the hardware and software it requires...".

Accenture's analysis also validates these data points and suggests a growing expectation on the part of end-users that a greater portion of companies' budgets will be directed to Auto-ID-related technologies.

RFID is anticipated to be the primary transport mechanism for the EPC™. Figure 3 examines the **low-cost RFID marketplace**. Projections show six-fold growth from 2001 to 2006, with the market growing from just over $20 million to over $120 million during that period. If $120 million spent 2006 was focused solely on low-costs tags that cost $.05 each, that would equate to 2.4 billion tags – a substantial amount.

Figure 3: Data Source: Frost and Sullivan, "World RFID-Based Application Market," August 2002, Depak Shetty.



Projections are that the overall RFID applications market will expand to approximately $7 billion by 2008 (Figure 4). While perhaps a more conservative view on the growth rate of Auto-ID, the growth volume is nevertheless significant.

What will drive companies to begin using Auto-ID technology? Some of the potential drivers for adoption of the technology are listed in Figure 5. Equally interesting is the number of items to which companies will be able to affix tags. If you consider consumer items that could potentially have Auto-ID tags applied to them (as illustrated in the Trade Unit Tagging segment of the chart in Figure 5), the number of items quickly climbs into the billions per year. Combine that number with items affected by requirements set by trading partners or other cost-driven supply chain issues (food safety, security, etc.), and the number

of items that could be tagged continues to escalate. The net result shows that the number of items that could potentially be tagged could exceed as many as 40 billion objects by the year 2009.

Figure 4: Data Source: Frost & Sullivan: "World RFID-Based Application Market," August 2002, Depak Shetty.

TOTAL RFID-BASED APPLICATIONS MARKET: REVENUE FORECASTS (WORLD), 1998–2008

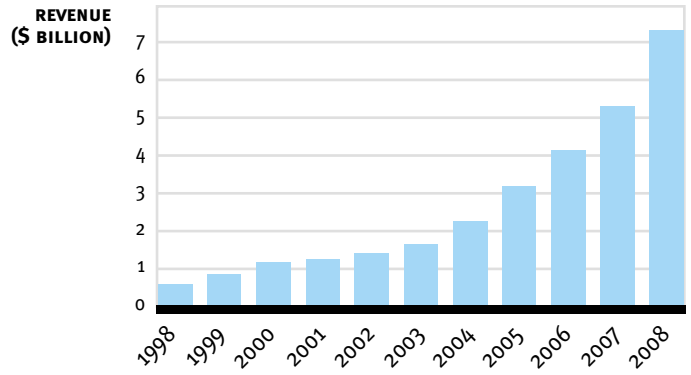
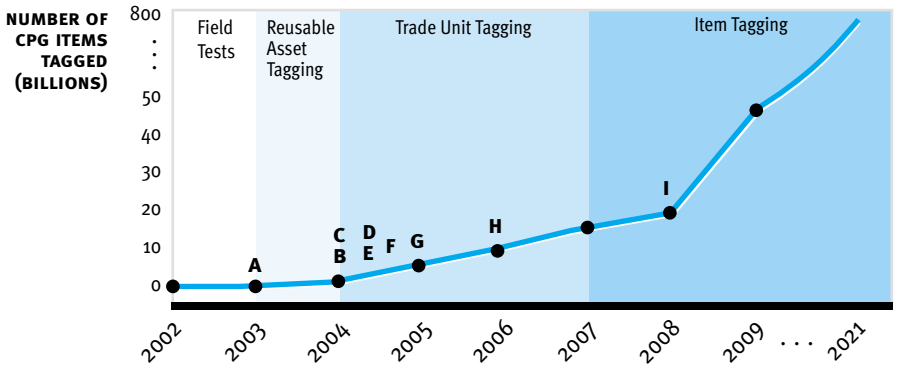


Figure 5: © Copyright Forrester Research, Inc. Source: "RFID: The Smart Product Revolution," August 2002.

DRIVERS FOR AUTO-ID ADOPTION



A 2003, Government Regulation for Cross-Border Trade
GB nations pass regulations calling for computerized customs inspection and quicker exchange of information on the contents of freight containers.

B 2004, Software Standards
SAP, Savi Technology and other software vendors standardize the middleware required for RFID supply chain deployments.

C 2004, Data Standards
EPC™/RFID pilots like the Field Test drive adoption of data standards for passive identification.

D 2004, Lower-Cost Tags
Tags reach $0.05 with 1 billion chips produced for use across all manufacturing sectors.

E 2004, Supply Chain Vendor's Investments
CHEP tags its wooden pallets and other reusable assets – which means that 25% of the reusable logistics assets in the CPG supply chain are "intelligent."

F 2004, Wal-Mart's Support
Once tags reach $0.05, Wal-Mart pushes for RFID at pallet level – and case level for products prone to stock-outs.

G 2005, Other Retailers' Support
Following the lead of early adopters, most retailers require RFID at pallet level – and case level for products prone to stock-outs.

H 2006, US Food Safety Regulations
Forrester expects Hazard Analysis and Critical Control Point (HACCP) regulations to drive RFID adoption for cases of perishable goods because of growing concerns about food safety.

I 2008, Tags Reach $0.01
On the heels of case-level tagging, making feasible item-level tagging for goods like over-the-counter drugs, cosmetics and cigarettes.

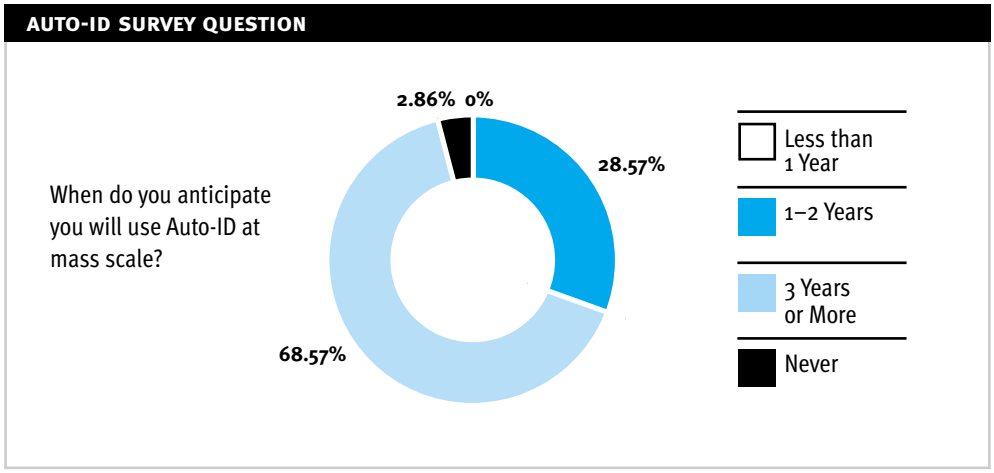
While the estimates of each of these forecasts vary, they all point to substantial growth in the size of the Auto-ID market. For technology vendors, this appears to be worth investigating. Information collected from the end-user companies that attended the Forum was consistent with these adoption trends, the highlights of which are described in the next section.

4.2. EPC™ Forum Pre-Event Survey Results

A survey was conducted before the EPC™ Forum that probed whether and at what rate companies would adopt Auto-ID technology. All attendees were invited to complete the survey in order to gain insight into their views prior to the start of the EPC™ Forum. While the quantity of responses does not make the data statistically significant, it does provide insight to the directional intent of the participants. The results of the survey are depicted in the next several figures.

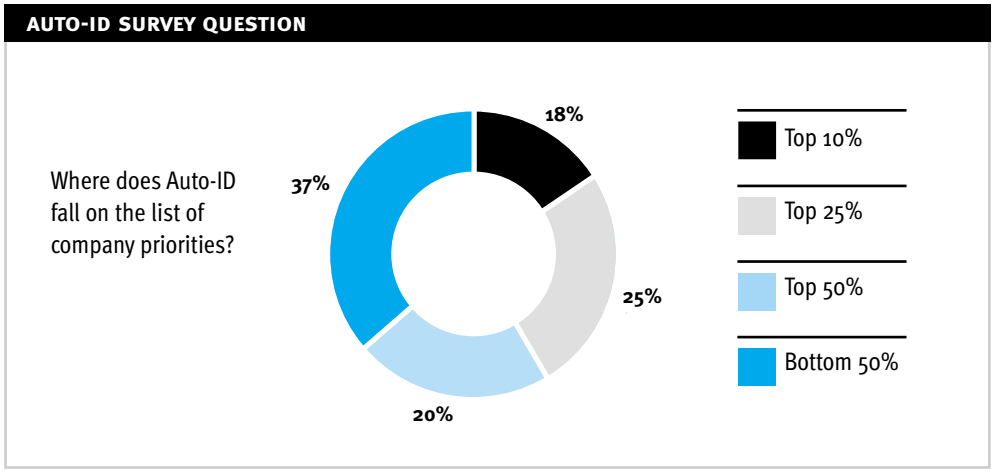
Figure 6 asks, "When do you anticipate you will use Auto-ID at mass scale (i.e., millions of tags)?" Among the respondents, almost 30 percent said that within the next one to two years they would expect to see a more common take-up of Auto-ID. Almost everyone agreed that there would be mass take-up of Auto-ID at some point in the future.

Figure 6



As shown in Figure 7, almost 20 percent stated that the implementation of Auto-ID technology is in the top 10 percent of their company's priorities. Almost half of the group said it was among the top 25 percent of priorities. These results suggest that within a three-year window, a significant number of companies will view Auto-ID as an area where they will dedicate resources and financial support. The results also support the notion that the growth in demand for Auto-ID will bring the market to meaningful scale.

Figure 7

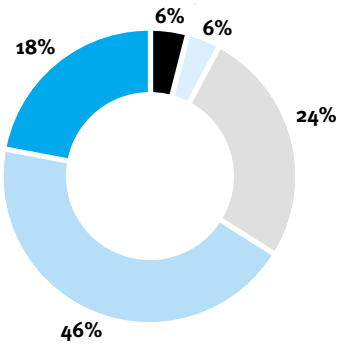


Responses to the question, "What percentage of products do you expect your company to be tagging by the end of 2004," (Figure 8) drew some interesting results. In the next 24 months, more than 80 percent of the respondents expect to be tagging at least some of their products. More than 35 percent predict they will be tagging at least 10 percent of their products and 12 percent indicate they will be tagging at least 50 percent of their products. This indicates there will be broad usage and that the volumes will be significant.

Figure 8

AUTO-ID SURVEY QUESTION

What percentage of products do you expect your company to be tagging by the end of 2004?



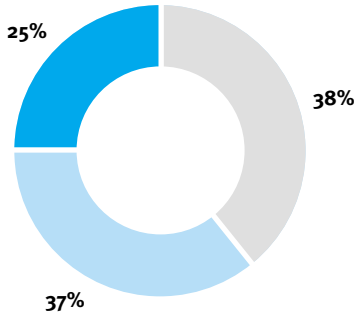
A key variable that will drive the number of tags used is the level at which tagging occurs, such as pallet, case or item. Conventional wisdom would say that tag usage will migrate from higher levels of item aggregation to lower levels (pallet –› case –› item) and that growth in volume of tags used would occur in parallel.

The next survey question asked, "At what level do you anticipate your company will be tagging products over the next two years? (Figure 9)." Surprisingly, more than 50 percent indicated they would be tagging at the case or item level in the next two years, which indicates they would not progress from higher to lower levels, but go straight to the lower level of tagging to obtain the greater benefits.

Figure 9

AUTO-ID SURVEY QUESTION

At what level do you anticipate your company will be tagging products over the next two years?

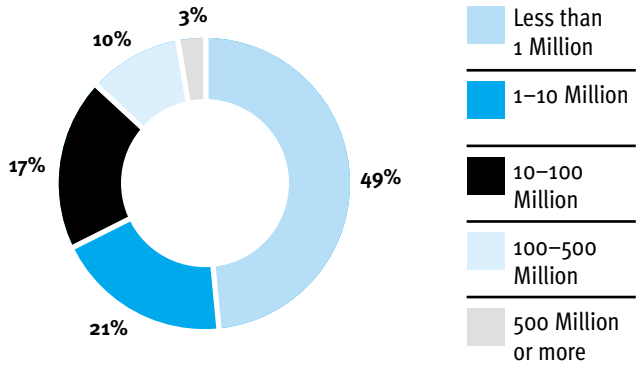


In Figure 10, more than 50 percent of the respondents indicated they would be purchasing at least one million tags by the end of the 2004, and more than 30 percent indicated they would be purchasing at least 10 million. In January 2003, Gillette announced the placement of an order of 500 million EPC™ tags. All of these data points are significant indicators of continued high-volume orders.

Figure 10

AUTO-ID SURVEY QUESTION

How many tags do you anticipate your company will purchase by the end of 2004?



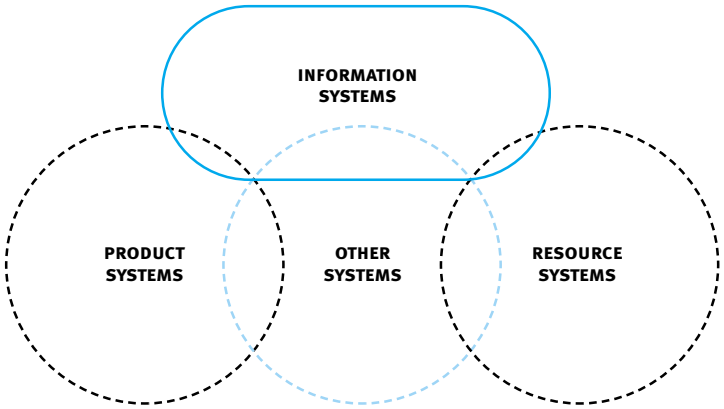
For technology companies evaluating the size of the Auto-ID market, these survey results all provide an indication that end-user companies may direct significant funding toward this technology in the next several years.

The next logical step a technology vendor must decide is what product, service or combination of both, does it want to offer? Each vendor will need to make its conclusions based on their core competencies.

The elements in Figure 11 can help technology vendors shape their market offerings. The diagram depicts the potential elements necessary to support an Auto-ID whole product solution.

Figure 11

AUTO-ID POTENTIAL TECHNOLOGY LANDSCAPE MAP



Information Systems
PML, Sales/Service Related (e.g. CRM, Field Service), AP, AR, GL, FA, Procurement/MRO, Pricing, Order Mgmt, Demand Mgmt Systems, Advanced Planning & Scheduling, Merchandising, Customer Service/POS, Mfg. Execution Systems, WMS, TMS

Product Systems
Packaging Design & Mfg, Product Designers, Tag Packaging, System, Tags, Readers/Antennas, Chip Manufacturers Sensors, Controller

Other Systems
Solutions Architecture, Network Architecture, Middleware

Resource Systems
Process Control System (SCADA, PLC, DCS, DNC), Infrastructure, POS Equipment, Shelving Systems, Storage Systems, Transportation/ Logistic Providers (Freight /3PL) Production Equipment, Materials Handling Equipment

The intent of this diagram is not to put any vendor in one category, for that may change, but to illustrate that there will be Auto-ID solution components that fit into each area. These areas include:

- **Product Systems**
  The tags themselves, and the equipment to contain, apply, read and track the EPC™ tags.

- **Information Systems**
  The business applications that use the data obtained from the EPC™ tags to execute transactions and processes that manage the business and support decision-making.

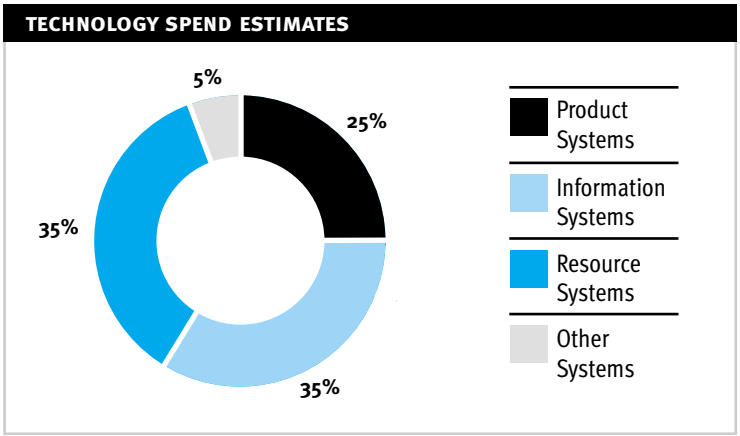
- **Resource Systems**
  The physical equipment used to manufacture, move and store products.

- **Other Systems**
  The network, middleware and other technical architecture used to connect the product, information and resource systems.

Today, there are no solutions available that encompass all of these areas, and it is unlikely there will ever be as they are too broad, complex and changing continually. Technology vendors can use this type of map to help explain what areas their offerings intend to cover. In addition, vendors could look at bundling a set of capabilities and components from each portion of the map to create a whole product solution that addresses a specific business application. This type of situation emphasizes the need for standards to enable interoperability between the various components to make a whole product solution.

The end-user community realizes it will need to pursue best-of-breed solutions in the near term and assemble the components themselves. The results of the final survey question are shown in Figure 12 and are based on the technology landscape map. The survey asked participants to allocate the costs of implementing an Auto-ID solution to each area of the landscape map.

Figure 12



The small allocation of costs to the Other Systems area is likely due to companies anticipating they already have many of these components, such as network infrastructure, in place. Most of their technology investment will go toward resource systems, product systems, or most importantly, the information systems that will enable them to take advantage of the data that will be captured and intercommunicated by the tagged objects. Better results will occur when companies adopt uniform solutions according to common standards versus a proprietary infrastructure as a solution.

4.3. EPC™ Forum Breakout Session Results

An entire half-day of the EPC™ Forum was used to conduct breakout sessions with end-users to drill into more detail regarding the potential application areas for Auto-ID technologies. Six sessions were conducted simultaneously. Participants were grouped based on their perspective in the supply chain (i.e., manufacturing and retail).

Five of the six breakout sessions focused on the manufacturer value chain, while one session focused on the retail value chain. The manufacturer sessions ranged in size from 12 to 15 participants with representation from many different product categories:

- Food & Beverage
- Consumer Electronics
- Health and Personal Care
- Media
- Pharmaceuticals
- Toys
- Stationery
- Firearms

The retail session encompassed approximately 25 participants with representation from various types of retail formats:

- Mass Merchant
- Discount
- Drug
- Grocery

Two facilitators led each session. The sessions were conducted concurrently using consistent techniques and exercises to capture information from participants. The facilitators consolidated the results of all the sessions and the results are summarized below.

4.3.1. Auto-ID Investment Plans

Generally, unless there is a government regulatory requirement, companies often require a business case or ROI analysis prior to undertaking any significant technology initiative. The six breakout sessions each had discussions regarding their respective company's Auto-ID initiatives, specifically discussing business case development, pilots and implementation rollouts. They discussed these initiative activities in the context of whether they were completed, initiated or planned.

Table 1: Retailer Participants' Completed, Initiated or Planned Initiatives

* (6–12 Months)

	COMPLETED	INITIATED	PLANNED*
BUSINESS CASE	23%	38%	31%
PILOTS	15%	23%	85%
ROLL-OUTS	0%	0%	46%

As shown in Table 1, well over half (61 percent) of retailers have either completed or initiated an Auto-ID business case, while another 31 percent plan to conduct a business case in the next six to 12 months. As expected, fewer have completed or initiated pilots to date (15 percent completed and 23 percent initiated), but surprisingly, another 85 percent plan to pilot Auto-ID in the next six to 12 months. This

indicates that some companies are willing to forgo the business case exercise because it is already intuitive that the results will be beneficial. At the time of the EPC™ Forum, none of the retailers had completed or initiated a rollout of Auto-ID technology, but a significant 46 percent plan a rollout in the next six to 12 months. Beyond the 12-to-18-month horizon, participants were asked when they expected their company might roll out Auto-ID technology (Table 2). Many of those who indicated they would not roll out in the 12-to-18-month time frame were close behind in the 2005 time frame.

Table 2: Retailer Participants' Expected Rollout

	2003	2004	2005	2006	› 2006	NO ANSWER
INITIATE ROLL-OUT OF AUTO-ID SOLUTIONS	8%	38%	23%	8%	0%	23%

As shown in Table 3, manufacturers, in general, lag the retailers in each stage of business case, pilots and rollouts. Twenty-one percent of manufacturers have completed or initiated business cases, while another 32 percent plan to conduct a business case over the next year-and-a-half. While only 5 percent of manufacturers had completed a pilot and 12 percent have initiated one, another 39 percent plan to conduct a pilot in the next year-and-a-half. Of the manufacturing participants in attendance, 1 percent had initiated a rollout and another 21 percent plan a rollout over the next year-and-a-half.

Table 3: Manufacturer Participants' Completed, Initiated or Planned Initiatives

* (12–18 Months)

	COMPLETED	INITIATED	PLANNED*
BUSINESS CASE	8%	13%	32%
PILOTS	5%	12%	39%
ROLL-OUTS	0%	1%	21%

As shown in Table 4, the longer time horizon of manufacturers' rollouts also lags the retailers. However, it is interesting to note that a greater percentage of manufacturers provided at least some indication of rollout time frame (90 percent) than did retailers (77 percent).

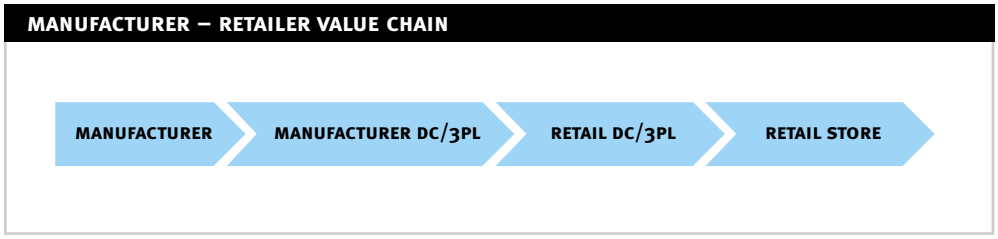
Table 4: Manufacturer Participants' Expected Rollout

	2003	2004	2005	2006	› 2006	NO ANSWER
INITIATE ROLL-OUT OF AUTO-ID SOLUTIONS	3%	25%	33%	13%	16%	10%

4.3.2. Application Priorities

The next breakout session exercise focused on prioritizing the application areas for Auto-ID within the supply chain. The "Manufacturer-Retailer" Value Chain shown in Figure 13 was used as the basic framework for the discussion.

Figure 13



Facilitators presented the value chain showing a list of application areas within each segment, then solicited feedback and discussion regarding this initial list of application areas. Hypotheses were then discussed by application area with respect to operational and financial benefit potential created by Auto-ID technology. Participants were asked to generate other potential application areas not listed, and then prioritize the potential areas from their own company's perspective. Finally, a ranking exercise was conducted to understand each group's top three application priorities for Auto-ID.

The top three application priorities for retailers (Figure 14) were inventory management, out-of-stocks and theft, with warehouse management a close fourth. Similarly, the manufacturer's top three application priorities (Figure 15) included inventory management, warehouse management and out-of-stocks. This indicates a belief that tagging inventory at the pallet, case and item level and strategically stationing readers throughout the supply chain can reduce excess inventory while better managing in-stock positions and controlling labor requirements.

Inventory management and out-of-stocks were identified as two of the top three application areas for both retailers and manufacturers. With these two areas being so closely related, it is clear these will be important application areas where Auto-ID will be used and the first area of investment by end-users.

Figure 14

RETAIL APPLICATION PRIORITIES

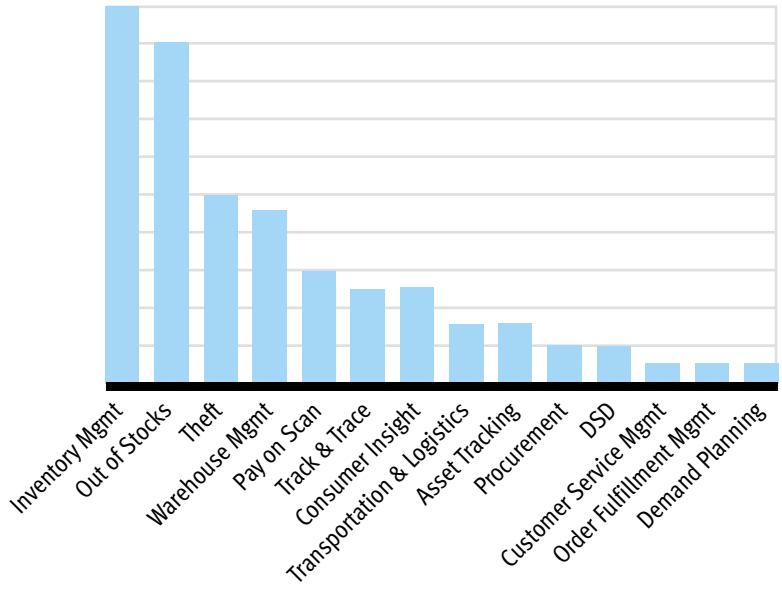
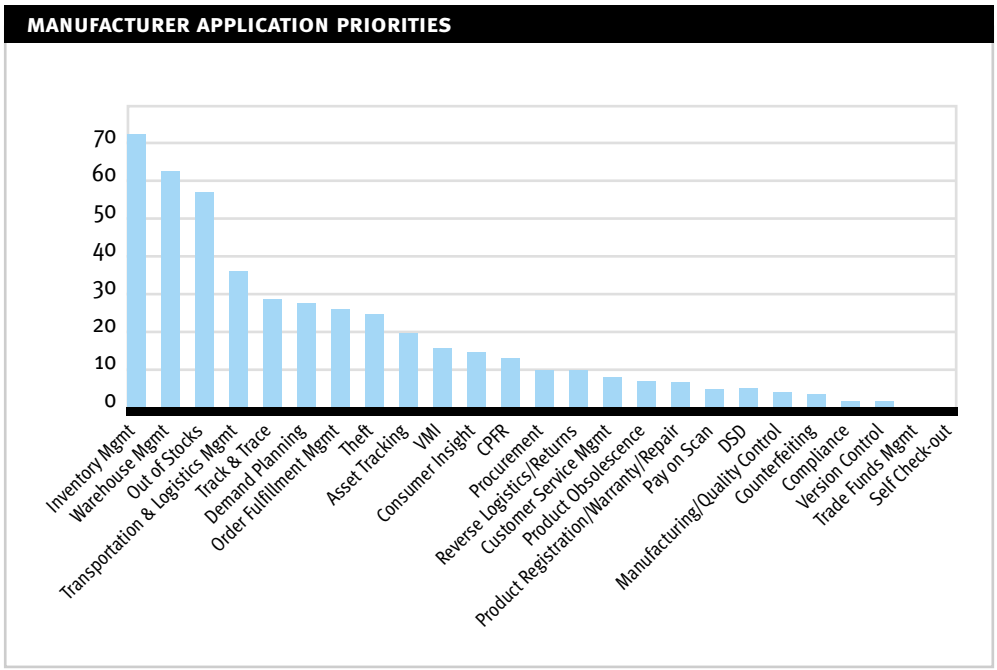


Figure 15



4.3.3. Key Drivers to Adoption

For the top three applications in the previous exercise, participants were then asked to discuss key drivers to adoption, as well as their operational and financial impact. Common themes from each break-out group were aggregated into the listing in Table 5 for retailers and Table 6 for manufacturers.

Table 5: Retailer Key Drivers to Auto-ID Adoption

APPLICATION	KEY DRIVERS	OPERATIONAL IMPACT	FINANCIAL IMPACT
INVENTORY MANAGEMENT	– Inventory Visibility and Accuracy across the Supply Chain	– Reduced cycle/ physical count – Improved in Stock	– Decrease in Working Capital – Reduced Labor Costs
OUT OF STOCKS	– Demand/Supply Synchronization – Lost Sales	– Improved Promotion Management – Optimized product location(s)	– Profit Optimization – Improved Turns – Increase Sales
THEFT	– Customer Service – Lost Sales	– Increased real time visibility to product status – Improved Measurement Capabilities	– Reduced Cost of Theft – Decrease in LP resources

Table 6: Manufacturer Key Drivers to Auto-ID Adoption

APPLICATION	KEY DRIVERS	OPERATIONAL IMPACT	FINANCIAL IMPACT
INVENTORY MANAGEMENT	– Increased Inventory Accuracy – Increased Inventory Visibility downstream and upstream – Improved Customer Service – Customer Requirements	– Reduced Labor and touches – Increased Inventory Turns – Reduced Obsolescence – Improved Service Levels – Enables pull based replenishment	– Reduced Working Capital – Reduced COGS – Increased Sales
OUT OF STOCKS	– 8–10% OOS problem, more for promotions – Sales growth – Maintain market share	– Increased Revenue – Increased Customer Service – Ability to measure velocity	– Increased sales – Increased margin/profits – Increased working capital efficiency – Reduce operating costs
WAREHOUSE MANAGEMENT	– Accuracy – Labor Efficiency – Throughput	– Picking & Order Accuracy – Automated data capture – Reduced cycle times	– Reduce labor cost – Reduce space requirement

Inventory management and out-of-stocks were discussed synonymously in most groups. Therefore, increased accuracy and visibility were common themes for inventory management among both retailers and manufacturers. Likewise, reduced labor, reduced physical/cycle counts, increased turns, reduced obsolescence and improved service levels were the most common operational objectives across the six groups, driving common financial impacts of reduced working capital, reduced labor costs and ultimately reduced cost of goods sold (COGS).

Key drivers for warehouse management were viewed to be accuracy, labor efficiency and throughput. Auto-ID is thought to be able to provide automatic data capture, providing an environment with reduced errors and to significantly reduce labor as compared to the existing barcode label scanning of today. Participants believed that these operational impacts will be able to reduce labor costs and space requirements.

Retailers said the primary driver for theft was improved customer service. Operational impacts discussed included increased real-time visibility to product status and improved measurement, which could in turn affect financials by reducing the cost of theft and decrease the time and expense spent on loss prevention.

4.3.4. Key Technology Requirements

To create a common framework for Auto-ID technology discussions, technology was aggregated into four general types: product systems, information systems, resource systems and other systems (illustrated earlier in Figure 11).

– Product systems were defined to include tags, tag packaging, readers/antennae, controllers, sensors and identification systems.

– Information systems were defined to include systems such as order management, enterprise resource planning (ERP), manufacturing execution systems (MES), warehouse management (WMS), transportation

management (TMS), pricing, merchandising, demand management, demand planning and scheduling, procurement and customer service/point-of-sale (POS) information.

– Resource systems were defined to include process control systems (PLC, SCADA, etc.), production equipment, POS equipment, storage systems and material handling equipment.

– The other systems category included solution architecture, network architecture and other necessary middleware.

Requirements for product systems that the breakout sessions developed included cheap tags and 100 percent accuracy read rates, ability to read all sub-units within a larger unit (i.e., ability to scan saleable units within cases on each pallet), the need to continue providing human-readable labeling even if bar-codes are eventually replaced, confirmation of scans to alert the operator that a read occurred correctly and the ability to scale due to the expected increase in read volumes over today's scans.

Discussion for information systems requirements focused primarily on integration across transaction management systems, planning systems, POS systems, execution systems and the importance of EPC™, RFID and Auto-ID technology leveraging existing legacy systems. The use of standards was identified as a significant issue.

Resource systems requirements discussed included the interoperability between systems, as well as visibility and sharing of EPC™ data across systems. Due to the nature of EPC™ and the amount of increased transactions, massive data storage will be a requirement, particularly for item-level tagging.

There was consensus from the end-users that identification of sub-units based on application-based aggregation was not the desired approach. They expect the reader to read each individual unit. Reading each sub-unit on a pallet will necessitate improvements in read capabilities. Application-based aggregation will require application and data storage architectures to be shared and interoperable across systems.

Other architecture and middleware systems requirements include a need to support increased network traffic/bandwidth, the ability to scale from pilot transaction volumes to rollout volumes across all systems affected. Also to be considered is the variability of timing updates (i.e., many systems currently use batch uploading at period intervals versus more frequent uploads that will be required for real-time transactions).

The results of these discussions are shown in Tables 7 and 8.

Table 7: Retailer Technology Requirements

PRODUCT SYSTEMS	INFORMATION SYSTEMS	RESOURCE SYSTEMS	OTHER SYSTEMS

– Cheap tags and Readers with reliable read rates
– POS and hand-helds with integrated optical and RFID capability
	– Integration with all tracking systems
	  – Ordering
	  – Returns
	  – Pricing
	– Allow for EPC/SKU information to feed into current systems
		– Integration with:
		  – Data management systems
		  – Analytics
			– Increased Network Bandwidth
			– Increased Data Storage
			– Middleware capable of scaling with rollout volumes

Table 8: Manufacturer Technology Requirements

APPLICATION	PRODUCT SYSTEMS	INFORMATION SYSTEMS	RESOURCE SYSTEMS	OTHER SYSTEMS
INVENTORY MANAGEMENT	– 100% read accuracy with error indication/ handling – Read all sub-units within larger unit (incl liquids, metals) – Rugged & Durable – Tags able to be read by multiple reader systems	– Integration of read data to transaction management systems (ERP, WMS, POS) – Ability for Auto-ID to leverage existing systems – Systems support security & data sharing	– Data storage architecture w/ interoperability, visibility & sharing – Transaction Volume	– Relationship between standards – Network architecture supports sharing of data between vendor and retailer
OUT OF STOCK	All from above plus: – Shelf/readers for item – Door readers for case/pallet	– Integration with transaction planning systems (ERP, DP, Inventory Mgt systems, etc.) – Integration with real time POS data – Ability for Auto-ID to leverage existing systems – Real time update to inventory mgmt systems – Capability to track inventory at more discrete points in a store	– Massive storage particularly for Item level tagging – Back room inventory monitored and tied to replenishment system – Integrated to security system – Infrastructure able to handle large number of transactions	– Middleware capable of seamlessly linking store readers to transactional systems – Network architecture supports sharing of data between vendor and retailer
WAREHOUSE MANAGEMENT	– Integrated with Human readable – 100% read reliability – Confirmation of reads – Scalable, increased transaction volume – Interoperability	– WMS – OMS – Data Warehouse – ERP	– Label applicators – Rack systems – Fork trucks	– Filters to prevent data overload – Variable timing of updates (batch vs. real-time)

4.3.5. Challenges and Barriers

Retailers and manufacturers alike found challenges with implementing Auto-ID today. Tables 9 and 10 list challenges separated into internal and external. One of the more significant internal challenges is new process design and implementation. If companies believe that they can simply substitute Auto-ID technology for existing barcoding and be done, then they have missed the boat on the true value opportunity. Substantial benefit may be yet to come from 1) redesigning processes to eliminate excessive labor and 2) implementing new processes for value-added capabilities made available through this new technology. Another big challenge was the issue of trust among trading partners, which will be a critical success factor to making Auto-ID work.

Sharing information among companies will be a key issue. Will data be considered intellectual property or will there be a charge to access information on the company's own products? Will companies be willing to work with trading partners to share customer and product information?

Most other internal challenges discussed were predictable. They included: competing priorities for business assets, ROI/business case, skeptics within the organization who ask you to "prove the benefits to me," lack of executive sponsorship and the need for additional education, awareness and internal communication.

External challenges of privacy concerns and consumer perceptions will face a particularly tough road to sell to consumers. Consumers already skeptical of credit cards, cell phones, E-Z Pass toll cards and Big Brother watching may never come around to the individual consumer benefits that can be achieved through new technologies.

Even if companies get past these issues and manage to implement Auto-ID within their own enterprise, achieving 100 percent read rates will be a key challenge. Enterprises can control and tune their own environment, but what happens when tags are scanned within other enterprise environments? What will the impact be for different equipment reading at different read ranges, orientation, temperatures and other such factors?

The fact that mom-and-pop grocery stores currently do not use barcode POS scanners, even while this technology has been in use for many years, provides an indication they may not want to use EPC™ soon, if ever. This would not allow all products to be scanned to the final point of consumption. This type of issue, however, will not need to be addressed until corporate entities get past their own hurdles of sharing EPC™ data across enterprise boundaries.

Table 9: Retailer Internal and External Challenges

INTERNAL CHALLENGES	EXTERNAL CHALLENGES
– New process design and implementation – Integration with existing systems – Competing priorities for business assets – Replacement of existing systems – High investment in current solutions – Lack of executive sponsorship	– Privacy concerns and consumer perceptions – Intellectual property rights – Legislation/government/policy – Data synchronization – External data management – Engineering challenges – Selling the benefits to: Vendors & Consumers

Table 10: Manufacturer Internal and External Challenges

APPLICATION	INTERNAL CHALLENGES	EXTERNAL CHALLENGES
INVENTORY MANAGEMENT	– Skepticism – "prove it to me" – Conflicting internal priorities – Integration across transaction systems – Cost/Benefit analysis credibility	– Tag costs & reliability – Environmental concerns – Accounting implications – Willingness of trade partners to share data – Various standards initiatives
OUT OF STOCK	Same as above	All from above plus: – Retailer commitments to address out of stock issue (Mfg. can only impact low percent of out of stock problem) – Willingness of retailers to invest in reader infrastructure for case level tagging
WAREHOUSE MANAGEMENT	– ROI/business case – Education, awareness & communication – Trust & reliability – Business priority – Process change reqmts	– Common data standards – 100% read reliability – Adoption readiness – Security, sharing of data, trust – Technology vendors capacity

4.3.6. Anticipated Deployment

Since dramatic differences exist by product category in terms of the economics of implementing Auto-ID, an exercise was conducted asking participants where and when they estimated that various levels of tagging would occur.

A chart was created with product category types on one axis and time in years on the other. Using three notes labeled "pallet," "case" and "item," participants were asked to place them in their respective product categories under the year in which they felt the appropriate level of tagging would begin. The results on deployment predictions are illustrated in Tables 11 through 14.

Since there was only one retailer group, the consensus of the group was easily summarized and represented by the indication of pallet, case or item in each year when tagging is anticipated to occur for the respective category (Table 11).

Table 11: Retailer Anticipated Deployment – Year Adoption Begins

	TODAY	2003	2004	2005	2006	2007	NEVER
GROCERY			Pallet	Case		Item	
CONSUMER ELECTRONICS		Pallet	Case, Item	Item			
HPC		Pallet	Case	Item			
MEDIA			Pallet				
PHARMA		Pallet	Case, Item				
TOYS		Pallet	Case, Item				
APPAREL			Pallet	Case, Item			

Five manufacturer breakout sessions occurred concurrently, so while each session reached consensus, the results had to be aggregated across all the sessions. The "Harvey balls" shown on the chart represent a range of consensus from the "minority" (empty ball) to the "majority" (full ball). Also, because of the aggregation across multiple sessions, each level of tagging (pallet, case, item) had to be represented on individual charts, which you will find in Tables 12, 13 and 14.

Table 12: Manufacturer Anticipated Deployment/Pallet Level – Year Adoption Begins

	TODAY	2003	2004	2005	2006	2007	NEVER
GROCERY			◑	●			
CONSUMER ELECTRONICS			◔	◕	●		
HPC		○	◑	●			
MEDIA		○	○	●			
PHARMA			◑	●			
TOYS			◑	●			
STATIONERY			●				
FIREARMS			○				

Table 13: Manufacturer Anticipated Deployment/Case Level – Year Adoption Begins

	TODAY	2003	2004	2005	2006	2007	NEVER
GROCERY			◑	◕	●		
CONSUMER ELECTRONICS			◔	◕	●		
HPC			◑	●			
MEDIA		○	◑	●			
PHARMA			◑	●			
TOYS			◑	●			
STATIONERY				●			
FIREARMS				●			

Table 14: Manufacturer Anticipated Deployment/Item Level – Year Adoption Begins

	TODAY	2003	2004	2005	2006	2007	NEVER
GROCERY				◔	◑	●	
CONSUMER ELECTRONICS				◔	◕	●	
HPC					◔	◕	
MEDIA			○	●			
PHARMA			◔	◕	●		
TOYS				◑		●	
STATIONERY					●		
FIREARMS					●		

The results highlight a one- to two-year lag on the part of manufacturers in deciding to adopt Auto-ID. It is possible that retailers will take action to incent and/or require suppliers to provide products with EPC™ tags before many manufacturers have taken serious steps to implement Auto-ID. The result will be that most manufacturers will seek standard, packaged solutions fairly quickly in order to meet rising retailer trading partner requirements.

5. CONCLUSION

Auto-ID has all the indications of being a high-growth market that is on the verge of taking off with enthusiastic customers ready to buy. Several business needs have been clearly defined and have clear value propositions attached to them, making the potential opportunities for technology companies attractive.

The following insights should be considered as companies evaluate how to proceed in their pursuit of opportunities in the Auto-ID market:

- Directional input from manufacturers and retailers is consistent in their early priorities, key barriers and technology considerations. The usage of Auto-ID technology will start in core supply chain distribution activities and expand out from there.

- The transition of use by "early adopters" to the "early majority" will probably occur in the next 12 to 24 months. A difference exists between retailers and manufacturers in the expectations of the investment and take-up pace; it appears that:
  - Retailers will pull manufacturers into adoption
  - Many manufacturers have not "heard" the message yet

- The most likely near-term Auto-ID application will be at the pallet and case level (2003) in several product categories. Item-level application still varies significantly by product category economics.

- End-users are looking for solutions that are based on open standards and interoperability. If you go proprietary, you go at your own risk.

- Business needs and quantifiable value will drive adoption of this technology. End-users are not going to buy solutions based on technology "flash." They are still feeling the effects of the dot-com era.

- Solutions that deliver real results to problems in the near term will have the greatest take-up. All of the solution components to address the problems need to be available, but end-users are willing to assemble what are thought to be best-of-breed solutions themselves.

6. APPENDIX

6.1. Auto-ID Primer

Introduction

Auto-ID technology consists of several parts: eTag – an electronic tag, Electronic Product Code™ (EPC™) – a unique identifier, Object Name Service (ONS), Savant Systems and Physical Markup Language (PML). By embedding the Electronic Product Code™ into products, intelligent and communicative objects result. This creates what Accenture refers to as a Virtual Double, where for every physical object there is an analogous data representation. In this sense, atoms and bits are aligned.

The Electronic Product Code™

The first component of Auto-ID technology is the EPC™. It is a string of numbers that provides a unique identification. For instance, instead of referring to a class of products (as Universal Product Codes do), the EPC™ refers to a specific instance of a product (see Figure 16).

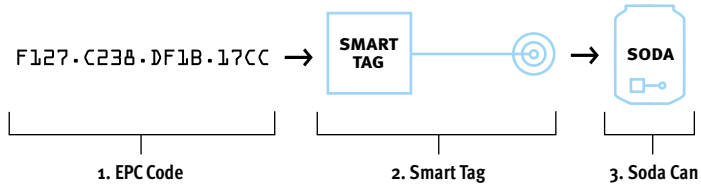
Figure 16:

1. EPC™ Code
Unique Number 96 bits long

2. Smart Tag
Made from a microchip with antenna – transmits EPC™ code

3. Soda Can
Typical Object becomes unique because of "Smart Tag"

INTRODUCTION TO AUTO-ID



To enable Auto-ID, the EPC™ is embedded in a memory chip contained within a smart tag on individual products. The chip is mated to an antenna. This allows for the smart tag to be scanned by a radio frequency "reader," which transmits the product's embedded identity code to a network, where the "real" information on the product is kept. That information is then communicated back from the network to provide whatever information is needed about that product. Auto-ID is the basis for current Auto-ID technology. It is important to note that the baseline functionality of these tags provides read-only access to the EPC™. No information need be kept on the tag.

The Auto-ID Center standard does not preclude other tags with read-write functionality or even more advanced capabilities. However, as additional functions and capabilities increase, so will tag cost. Read-write tags also tend to be slower as well as shorter range than their read-only counterparts. Additionally, implementation of EPC™ does not depend on Auto-ID technology; any way of being able to quickly and easily read a unique ID from a product will work. Auto-ID is the most likely option today, but technologies not yet commercialized (such as amorphous metal threads or ultra-wide band) may also play a part (see Figure 17).

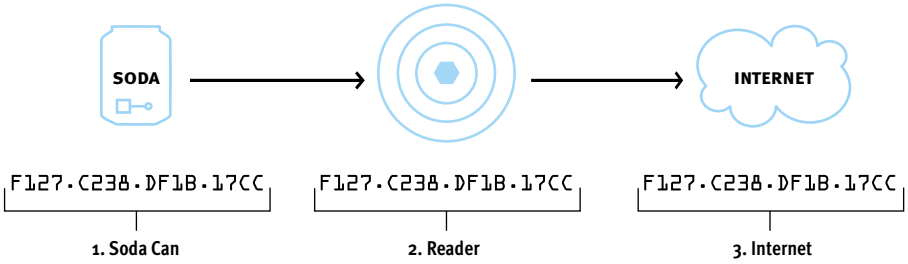
Figure 17:

1. Soda Can
Transmits EPC™ Code from embedded "Smart Tag" on side of can

2. Reader
Could be found in shelving, appliances, etc. Transmits EPC™ to Internet

3. Internet
Uses EPC™ to access unique object information

TRANSMITTING EPC™ CODE



The Object Name Service

The next step in the Auto-ID chain is the Object Name Service (ONS). The ONS tells computer systems where to find information about any object that carries an EPC™. ONS is based in part on the Internet's existing Domain Name System (DNS), which routes information to appropriate network interfaces. The ONS will likely be many times larger than the DNS, serving as a lightning fast "post office" that locates data for trillions of objects carrying an EPC™.

The Physical Markup Language

Physical Markup Language (PML) is a new standard "language" for describing physical objects in the same way that Hypertext Markup Language (HTML) is the common language on which most Internet Web pages are based. Almost anything can be contained within the PML description of an object: its physical characteristics such as weight or caloric content, repair instructions and audit trails. PML will allow for manufacturers to specify and customize the information tracked on products. There will not be a vast repository of PML descriptions. Ultimate implementation of the PML descriptions will result in highly distributed data. Manufacturers, retailers and consumers will all have unique views to data. One probable outcome of Auto-ID technology is that in the same sense that product is shipped, so will access to information or the information itself.

Applications

Auto-ID applications are numerous. They include manufacturing process control (flexible manufacturing, outsourcing), inventory management (retail stocking, spare parts, and back-room supplies), supply chain optimization (distribution center operations, transportation, ordering and replenishment), regulatory compliance (customs, security, tariffs), recall management and recycling.

In all these areas, Auto-ID offers the potential for significant savings, as well as new potential sources of incremental revenue. New services may start to emerge as objects start to become smart and interactive. As the technology becomes pervasive, benefits seem likely to extend throughout the entire value chain.

Auto-ID technology has the capability to redefine the global marketplace by embedding intelligence, identity and Internet connectivity into everyday objects. The EPC™ unites elements of the entire supply chain, making it an interactive, dynamic cycle from raw material and distribution to point-of-purchase and recycling, and back to raw material. Products equipped with smart tags can interact with manufacturers, their trading partners and each other to form a more efficient cycle of direct, real-time supply and demand.

6.2. Challenges

As with any revolutionary technology, there will be challenges to overcome in Auto-ID implementation. Some challenges are technological in nature, some economic, and some societal. The following topics outline these challenges and seek to address how to overcome them.

Accuracy
Readers cannot be guaranteed to be able to communicate with all tags in a volume 100 percent of the time. Environmental issues, the makeup of the products being tagged and the volumes of tags to be read all impact read accuracies. Nothing is foolproof. The degree of concern is proportional to how much an enterprise relies on absolute data.

Auto-ID offers many advantages over manual or semi-automated data collection processes. Any shortcomings in accuracy can be mitigated through the use of redundant readers, information auditing and process redesign. If tagging at the pallet and/or case level, fewer tags will need to be read and accuracy will increase.

Interference
As readers proliferate, more occurrences of interference will be documented. Depending on the frequencies and powers used, devices such as phones, wireless handsets and industrial equipment may be affected. Since such a widespread penetration of RF technology has not been undertaken before, it is difficult to state explicitly what will be impacted. Good engineering and proper tuning will be important in overcoming this challenge.

The perceived health risks of this much RF may also come into play. While there is no evidence that there are any negative effects at the power and frequency levels associated with Auto-ID, no one has rolled out such large-scale implementations yet. More research and monitoring will need to be conducted to address the public's concerns in this matter.

Performance
Smart objects will generate tremendous amounts of data. This much data will not be accessible if stored in a massive central repository, so some distributed data will be necessary. How will this distributed data be managed? Will it be accessible? How will it be accessed? The Auto-ID standard calls for read-only tags with a unique identifier. However, it is not hard to see mission-critical applications where this is not a viable option. For instance, in field service, remote locations, or even on airport ground areas, speed of network access cannot be guaranteed, and it will be much more convenient to have data on the tag.

Speed of information access is important. Subsecond lookup times will be expected in many applications. Where data is kept, as well as the networking infrastructure and computing platform, will greatly influence this speed. Simply put, for EPCs™ to work, the data associated with a given EPC™ must be available on demand.

Frequency Availability
Since Auto-ID uses unlicensed RF spectrum, the available spectra that is usable for Auto-ID is an issue. Although there are some frequencies that are common, there is no universal standard. 13.56 MHz and 2.45 GHz are both worldwide standard ISM frequencies. These are available in most parts of the world, albeit at slightly different restrictions. However, more useful in terms of read range and speeds are tags operating at roughly 915 MHz or ultra-high frequency (UHF). The UHF spectrum around 900 MHz is not universally available at the same frequency and power levels worldwide.

This will be addressed through two potential methods. The first alternative is multi-frequency readers. Overall RF system design (integration of antenna, readers and tags) is the most difficult part of the problem. The second is to select a common frequency. Obviously, since this involves millions of stakeholders, the lead time on this will be considerable. This does not, however, deal with the fact that not all frequencies work well for every application (although some work well across virtually all applications).

Security

Security is paramount, and contains many levels. There is read security (or being able to read the tag), security of the data, and many other security issues. For users of the technology to feel comfortable, there will need to be assurances that no one will be able to "hack" into a smart object. As long as tags are read-only and are difficult to counterfeit, then security will be somewhat a given. Users of Auto-ID technology will also need to rely on the security of Auto-ID data on the network.

Data Ownership

Related to security, data ownership is an issue. Who "owns" the massive amounts of event information associated with an object? It is clear that the manufacturer owns the design specs and other PML type data for a given product. It is clear who owns captured data – the owner of the reader that reads the tag. It is less clear, however, how information will be shared.

Many parties will be privy to and will update the data for an object as it passes though a supply chain. Will those collecting the data even want to share data (consider a shipper with less than stellar turn-around times – would they be interested in sharing item-level tracking information?). Does an end-user (consumer) ultimately "own" a product and its data, and if so, how does use of that data for process improvement or data mining impact privacy?

Lastly, although killing a tag when purchased has been discussed as an option, this method eliminates future recycling benefits, and also introduces the potential of tags being killed maliciously or by accident, before they should be.

Privacy

Finally, a large, mostly perceived risk in Auto-ID, falls within the area of privacy concerns. The idea of tracking products into the home is troubling to most concerned parties. Consumer fears in this area are sparked by a lack of understanding of the limitations of Auto-ID. Education is the key here – as people learn about when and how the technology works and what exactly is stored on the tag, the privacy concerns may lessen. Also, as consumers see value in the technology, acceptance will increase. For instance, consider stored warranty information that can help a consumer if repairs are needed or recycling information that can earn them a credit for being environmentally conscious.

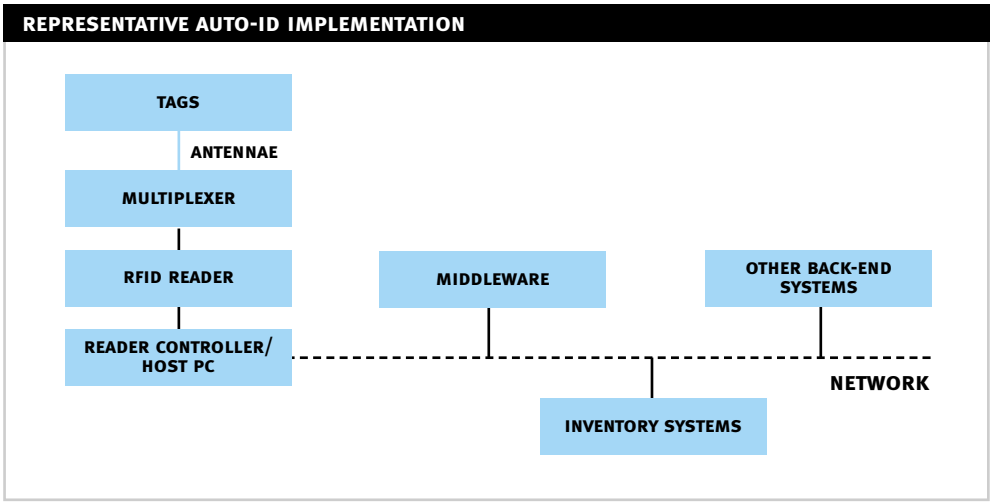
Even with education, there are some legitimate competitive issues. Retailers may see the technology as an aid to their competitors. For instance, since the EPC™ will be global and unique, it may be possible to determine specific product information from the EPC™ given enough data. Imagine knowledge of your competitors' shelf assortment and inventory levels gained through a store walkthrough, accompanied with a hand-held reader. This information is available now. The technology simply makes it easier to obtain.

6.3. The Elements of Cost

The Basics of Cost

Radio frequency identification (Auto-ID) tags are the most frequently cited cost component in Auto-ID implementations. This is not the whole story. Tags, readers, antennae, controllers, middleware, operations and maintenance all contribute to the total cost of ownership. Only by factoring in all of these components, tailored to a given situation, can costs be accurately estimated. Figure 18 gives a schematic of the various components of an Auto-ID system rollout. This section outlines each of these components and offers recommendations to calculate the overall cost in a business case for Auto-ID.

Figure 18



Tag Costs

Auto-ID **tags** are usually the first of the costs associated with an Auto-ID system. There are as many tag variants on the market as there are potential applications. Changes in form factor, memory capacity, read or read-write capability, active or passive configurations and range, all impact the cost of tags. When calculating tag costs, the application requirements are the primary driver.

The target cost of an Auto-ID Center compliant tag is five cents, i.e., read-only containing an EPC™. Note that this cost is a future "volume" target. By way of comparison, commercially available read-only tags in the UHF spectrum today cost approximately 50 cents per tag, in volume.

The cost of the tag is not the final figure. Conversion costs must also be factored in. Conversion in this case means application of the tag to a product's packaging, to the product itself, or to cases or pallets. It also implies associating the EPC™ code with the actual product, known as "commissioning." Commissioning may mean writing the preassigned EPC™ to the tag (or programming) or alternatively, reading the predefined EPC™ value on the tag. Then the proper PML associated with that particular EPC™ should be updated.

The product being tagged will greatly influence conversion costs; will the tag require a standoff (in the case of metal mounts)? Will the tag need to be concealed? Will the tag antenna be printed or metal coil? These factors will increase the baseline tag cost. How much of an increase depends on the application. If the tag requires a printed label, then a label printer/Auto-ID writer may also need to be purchased.

Reader Costs

Readers energize passive tags with energy, receive the results and very often, handle the low-level anti-collision algorithms that allow readers to read more than one tag at a time. Readers are generally controlled via application programming interfaces (APIs) that are provided by the reader manufacturer. Generally, the API also allows for configuring the reader's read cycle, power or other settings. The API for a given reader may have additional costs associated with it, although many providers bundle the software.

Reader costs vary as a function of range, speed, robustness, network readiness and antenna capability. The longer, faster or more hardened a reader is, the higher the cost. For readers at the lowest end, a PDA application may run $200 USD. For shelf or forklift installations, readers may reach $2,500 USD, and for high-speed conveyor or dock door applications, from $2,500 up to $10,000 USD. These ranges are based on today's commercially available equipment, although they will drop as volume of readers produced increases.

Antennae and Multiplexers

Antennae are another component of the reader subsystem. Whether it is a shelf, mat, portal, wand or directional antenna, different antennae will be required for different applications. These can range in cost from $25 to $500 USD, depending on application and base operating frequency

Depending on how many antennae are required, one or many **multiplexers** may be necessary. A multiplexer allows many antennae to be physically connected to a reader. Expect to pay $500 to $2,000 USD per multiplexer, depending on the number of ports. A configuration using multiplexers may also require an additional communications card such as an RS-485 (roughly $250 USD) on the controller.

Lastly: **cabling**. As in high-end audio, cables really do matter. Although there are generally fewer limits on the distance between reader and controller, there are signal degradation effects in the cables connecting readers and antennae. High-grade RF cables for this purpose can be expensive. Look to spend up to $10 USD per linear foot, keeping in mind distance limitations.

The entire reader/antennae/multiplexer setup may be referred to as a "read point."

Installation

Installation is the next major cost. Physically mounting antennae, power supplies, multiplexers and readers can be costly, depending on the environment. Many readers will need to be installed in warehouse or industrial environments. Still others will be installed on equipment such as forklifts or various handling equipment. Retrofitting existing sites or material handling equipment can add to the cost.

Readers and antennae may need to be concealed if aesthetics are to be considered (such as in a retail environment). In the case of a warehouse or plant installation, equipment may need to be hardened to handle the environmental abuses that come with such locations. Power drops, often at union rates, must also be provided to the location of the readers. Depending on the environment (for instance, retail stores may not have power available at all merchandise locations) this cost may be considerable.

As with power, network capability may also be required. This is a "may" because the reader and controllers may utilize existing wireless LAN capability to communicate with other systems. Otherwise, some sort of connectivity will be required between the controller and the reader. This can be Ethernet (CAT-5) or other serial communication. This cabling must also be installed, shielded or concealed, depending on application.

Controller costs

For every reader or group of readers a **controller** will be required. A controller is simply a computer, running software to control the reader. Initial processing, event firing and some diagnostics run on this PC. The controller need not be a very high-end PC unless it needs to be hardened for factory or other industrial applications. Approximate cost: $1,000 to $3,000 USD.

Tuning

Another cost in an Auto-ID solution is the **tuning** phase. Every physical environment will interact with radio frequency waves in a different fashion. The RF field will need to be measured for dead spots and adjustments made. This cost is highly variable, given the expertise needed, selection of reader systems, and the vagaries of RF fields.

Software Costs

The next level up from the hardware is the controlling software, or **middleware**. This software translates tag reads into business events. Middleware is where much of the action takes place and is justifiably receiving a lot of attention.

The middleware will be a distributed system. At the very least, it will run on one or more servers plus the software running on controllers. All middleware serves pretty much the same function: it translates tag events into business events, aggregates data from item-level actions to those used in current Enterprise Resource Planning (ERP) and Warehouse Management Systems (WMS) systems, and provides publish and subscribe interfaces, so that applications may register interest in business events. The middleware will provide abstraction layers for connecting various types of readers and will provide for basic business rule engines. Furthermore, middleware should provide for read point monitoring and diagnostics.

However, it is important to realize that almost every implementation of middleware will be highly dependent on business rules, existing systems and the desired level of control. Commercial variants of middleware include the Savant from the Auto-ID Center, Accenture's Silent Commerce Infrastructure, ConnecTerra, SAP's Adaptive Networks and Savi's SmartChain and UDAP. These all vary in cost, from free (in the case of the Savant) on up, however their capabilities also vary greatly.

Integration Costs

No matter what the middleware chosen, integration costs will be a large factor in an Auto-ID implementation. It will be in the order of magnitude of the cost of readers and installation combined, depending on the number of legacy systems affected. It goes beyond simple integration. Some systems may need to be replaced altogether if they are not capable of taking advantage of incrementally large volumes of real-time data from Auto-ID technology.

Maintenance

In addition to one-time costs, the ongoing maintenance and upkeep of an Auto-ID system should be factored into ROI calculations. Factors influencing maintenance include hardware upgrades, replacement of failed or damaged equipment, ongoing firmware and middleware upgrades and any software or licensing fees. Also, ongoing tag purchases and battery replacement (for active tags) should be factored into operations and maintenance costs. A standard software license and maintenance agreement usually runs approximately 10 percent per year. This is a good estimate for these systems. Finally, since so much physical infrastructure is involved, the depreciation of equipment must be factored in as a cost item.

Workflow

The last pieces of the puzzle are the process and human elements of Auto-ID. Many existing processes, especially intercompany processes, will need to be redesigned. Current batch, or paper-based processes will need to be eliminated and reinvented. Essentially, new workflows may need to be created.

When more information is available through Auto-ID, increasing peoples' ability to act on that information must also be enhanced. Training of personnel in new processes and technology should be added into overall implementation costs. Journey management will become a necessary discipline in order to fully address Auto-ID implementation at scale.

7. REFERENCES

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