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Auto-ID on Demand: The Value of Auto-ID Technology in Consumer Packaged Goods Demand Planning

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Adoption of Auto-ID Technology Producing Dramatic Improvements for Consumer Goods Manufacturers

CHICAGO – When Earth Brands became "category captain" at both the Number 1 and Number 2 U.S. discount retailers, a reaction of surprise and alarm among competitors rippled through the consumer goods industry. Why? Earth Brands' sales volume had been a distant Number 3 at both retailers. Earth Brands' ability to outmaneuver competitors has added to quickly mounting evidence that companies who have adopted Auto-ID technology are demonstrating superior performance in delivering cost savings and service effectiveness.

Joan Lopez, CEO of Earth Brands, described her initial experience. "When Jim [Davison, Senior Vice President of Customer Service & Supply Chain] came to us with the prospect of applying advanced Auto-ID technology, we were skeptical about whether it could truly tackle our toughest issues," she said. "But, within two months of implementation," Lopez continued, "it proved to be the centerpiece of our operation. Forecast accuracy and inventory reduction benefits far exceeded even our most optimistic projections. In fact, it has contributed such an improvement in our performance, that I now see it as my responsibility to be an evangelist. Auto-ID technology has helped achieve the one thing that counts: growing the value of Earth Brands."

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 future scenario described above? Accenture has a vision for radio frequency 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, IL; Palo Alto, California; and Sophia Antipolis, France.

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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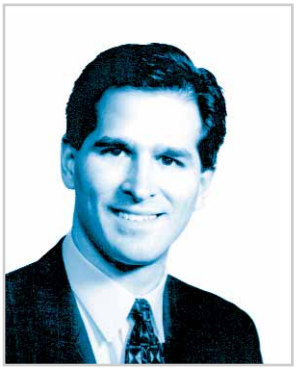
Biographies

Gavin Chappell
Partner

Gavin Chappell is a Partner in Accenture's Supply Chain Global Service Line. For over 13 years, Gavin has specialized in developing and implementing solutions to drive improvements in Supply Chain operations, specializing in physical distribution and inventory management. He has worked extensively in the UK Retail sector and across Europe for both Retail and consumer goods companies. He is leading Accenture's Supply Chain practice in the adoption and implementation of Auto-ID solutions. Gavin has an honors degree in Chemistry from the University of St. Andrews, Scotland.

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 Retail, Consumer Goods, Transportation, Hospitality, Pharmaceuticals, Life Sciences, Automotive and Industrial industries. Lyle has a Computer Science degree from Northern Illinois University.



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 degree from the University of Wisconsin-Whitewater.

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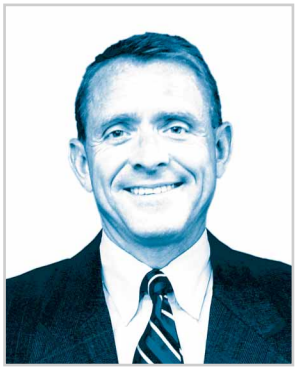
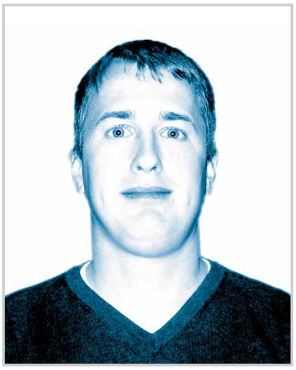
Biographies



Jeffrey 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 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 Auto-ID technology 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.



Joseph Tobolski
Senior Manager

Joseph Tobolski is a senior manager in Accenture Technology Labs. His main areas of expertise are Silent Commerce, Content Management, Collaboration and Knowledge Management and technical architectures. Joseph serves as the director of Accenture's Silent Commerce Center, where he is investigating how emerging technologies such as RFID, sensors and actuators can enable inventory management, maintenance and logistics. Joseph received his M.S. in mechanical engineering and his B.S. in industrial engineering from the University of Illinois at Urbana-Champaign.

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Contents

1. EXECUTIVE SUMMARY

Demand planning is a critical business process that impacts Consumer Packaged Goods (CPG) companies' ability to manage their value chain business performance. Revenues, costs and asset utilization are all affected by the quality, timeliness and accuracy of demand planning. Auto-ID technologies – Electronic Product Codes (EPC)™ and radio frequency identification (RFID) technologies – offer new enabling solutions that can dramatically improve the demand planning process and yield business results, measured on the income statement and balance sheets of CPG manufacturers and their trading partners.

Auto-ID technology can enable increased certainty of the demand signals throughout the supply chain improving demand planning forecast accuracy by 10–20%. Benefits from improved demand plan accuracy include:

- product will be manufactured and distributed in closer alignment with true demand resulting in increased sales of 1–2% from fewer out-of-stock situations, and lower costs due to unsaleables
- safety stocks at all points throughout the supply chain will be reduced, decreasing inventory levels by 10–30% and improving the use of precious working capital
- manufacturing and distribution capacity will be used more efficiently, improving asset utilization and reducing the need for capital expenditures

In order to obtain these benefits, CPG manufacturers will need to embrace new technical infrastructure, a renewed emphasis on information sharing practices, and the recognition that product category economics will heavily influence the deployment of Auto-ID technology, from container to truck to pallet to case to sellable item. Accenture's research concludes that many product categories will realize benefits without tagging sellable items.

Our conclusion: all stakeholders in the supply chain (suppliers, manufacturers, distributors, retailers and service providers) who embrace Auto-ID standards and collaborate with their trading partners, can achieve significant improvements in top line growth, bottom line profitability and consumer satisfaction.

2. ACKNOWLEDGEMENTS

Accenture would like to acknowledge and thank the many companies, organizations and individuals whose insights proved invaluable to this paper, including the Auto-ID Center, CHEP, The Home Depot, Intermec, Matrics, Procter & Gamble, Savi Technology, Target Corporation, Unilever and Wal-Mart.

3. INTRODUCTION

This white paper focuses on the key value driver of 'certainty' regarding product in the supply chain – and how Auto-ID solutions raise the certainty of product information, driving new value creation potential for CPG manufacturers who adopt this technology for competitive advantage.

A basic understanding of Auto-ID technologies is helpful in order to analyze the potential benefits and implications outlined in this white paper. An overview of Auto-ID technologies is included in Section 10.1 – Auto-ID Primer. Additional information can be obtained from the Auto-ID website[1].

[1] **Auto-ID Center**
http://www.autoidcenter.org

The high-level application of Auto-ID across all functions and industries is discussed in the Accenture white paper, "Auto-ID Across the Value Chain: From Dramatic Potential to Greater Efficiency & Profit" by Ajit Kambil and Jeffrey D. Brooks. For additional in-depth analysis of the application of Auto-ID technology for retail and freight transportation companies, please see the Accenture industry white papers, "Auto-ID on Delivery: The Value of Auto-ID Technology in the Retail Supply Chain" and "Auto-ID on the Move: The Value of Auto-ID Technology in Freight Transportation", that are also available on the Auto-ID website.

The focus of this white paper is on the demand planning function within CPG companies, and the opportunities enabled by Auto-ID technology. Demand planning impacts the three 'W's of product: what, when and where to make and ship to satisfy customer requirements. Sourcing, manufacturing and distribution are all affected by the demand plan. A significant portion of a CPG company's working capital is committed to inventory stored at various points in the supply chain, in order to buffer demand and supply variability, particularly in finished goods.

Systems used to calculate demand plans rely on varying algorithms and data inputs. Best-in-class systems consider historical data (customer orders/shipments), internal data (inventory levels), external data (trading partner customer orders and inventory levels) and causal factors (promotions, seasonality, anticipated growth, weather, etc) in order to calculate the demand forecast. The quality of the data used by the demand planning system will be a major factor in the accuracy of the forecast. Auto-ID technology may provide a way for CPG companies to increase the quality of the data they use for demand planning, generating planning and operational benefits.

4. THE BUSINESS PROBLEM: ACCURACY IN DEMAND PLANNING

Today, the CPG manufacturer is penalized for demand planning performance problems. Three significant business problems trace their root causes to the demand planning process:

- Unsaleables
- Invoice Accuracy
- Out-of-stocks

4.1. Unsaleables

"Unsaleables Update"
Volume 2 Number 3
Food Marketing Institute,
Summer 2002

Unsaleable product is defined as 'wrong product/wrong place/wrong time'. In the most recent Unsaleables Benchmarking Study, published by the Joint Industry Unsaleables Committee, the cost of unsaleables reached an all time record high of 1.14% of sales across all retail channels. In the grocery retail channel alone, manufacturer unsaleables sustained a level of 1.27% of sales. This translates into over $5 billion per year in excess manufacturer cost realized in salvage, customer reimbursements and diverted products, due to 3rd-party salvage.

Additionally, unsaleables have a negative effect on the customer relationship. The Benchmarking Report comments that 27% of manufacturers report 'no collaboration' with their retail customers on unsaleables. Retailers today do not share information on unsaleables and in some cases, even make unsaleables a profit center.

4.2. Invoice Accuracy

Grocery Manufacturers of America
Invoice Accuracy Best Practices Study
Accenture, 2001

Invoice accuracy is also affected by demand planning performance problems. As products are shipped 'over and short' or short-code dated e.g. with inadequate remaining shelf life (RSL), retailers respond by generating unexpected invoice deductions to the manufacturer. This leads to the 'lose-lose' scenario described in the Grocery Manufacturers of America (GMA) Invoice Accuracy Best Practices study conducted by Accenture, where retailer vendor payables personnel pursue the management of invoice deductions and 'Customer Service Expediters' or similarly-titled CPG manufacturer personnel, redundantly identify, track, research and report on invoice inaccuracies/discrepancies created by a mismatch of retailer expectations and CPG manufacturer performance in fulfillment. In addition, a demand planning solution that utilizes inaccurate historical invoice information will inherently generate an inaccurate future forecast.

While other issues contribute significantly to invoice accuracy problems (price/promotion discrepancies are a major culprit today), the existence of quantity/fulfillment-based discrepancies remains a wasteful, lose-lose root cause of invoice accuracy problems, costing both retailer and CPG manufacturer time, working capital and general and administrative expense, to manage and clear.

4.3. Out-of-Stocks

Shopper satisfaction surveys consistently find that one of the top reasons that shoppers choose a particular store is that 'they are in stock with my favorite brands when I go to shop there'. At SMART STORE®, Accenture conducted regular research into shopper attitudes in order to understand their likes and dislikes in relation to the shopping experience. Our research confirmed the survey results and highlighted the importance of in-stock position at the shelf for both retailer and CPG manufacturer sales success.

"Full Shelf Satisfaction: Reducing Out-of-Stocks in the Grocery Channel"
Grocery Manufacturers of America, 2002

"Where to Look for Incremental Sales Gains: The Retail Problem of Out-of-Stock Merchandise – A Study conducted by Andersen Consulting for the Coca-Cola Retailing Research Council"
Accenture, January 16, 1996

Recent research by the GMA into the out-of-stock situation in North America has identified a major problem in meeting this shopper satisfaction objective – with 8% of products in a supermarket out-of-stock at any particular time. Even more damning, 20% of promoted products are out-of-stock at the shelf, meaning that the shopper faces a 1 in 5 chance of coming to the store to seek a particular product that is advertised but unavailable. The impact of this fulfillment failure is often a loss of sales for the CPG manufacturer as the time-starved shoppers substitute the product that is on promotion with another brand that is in stock. Accenture's research for the Coca-Cola Retailing Research Council indicates a potential for lost sales of 3% annually to CPG manufacturers due to out-of-stocks – equating to a $12 billion revenue opportunity.

One great frustration shared by the retailer and manufacturer: systems show acceptable inventory levels at the store, but the shopper leaves empty-handed. Many times, the product is in the store – but not on the shelf. Existing in-store retail inventory systems lack the precision required to identify SKU-level inventory locations within the store. Accuracy and timeliness of product on-hand information in-store and through the supply chain becomes the critical Achilles heel of demand planning success – and the blister on that heel called 'out-of-stocks' causes pain for the shopper, the retailer and the CPG manufacturer.

5. THE ANSWER IS CERTAINTY

When a demand planning professional is asked 'what one thing would make you more effective in your job?' the answer we hear again and again is: 'Certainty – knowing for certain what my supply position is and what my demand requirements are'.

Many CPG companies acquire data from A. C. Nielsen, ems, Information Resources, Inc. (IRI) or Retail-Link, to obtain visibility to consumer demand at point-of-sale. Additionally, many CPG companies invest in proprietary data collection systems to track inventory levels and demand signals at intermediate points within their own and their trading partners' supply chain.

The information collected from these sources is substantial and various techniques and processes are used to make the inconsistent, incomplete and sometimes out-of-date data usable. Manual allocations and sampling techniques are used to extrapolate demand signals when limited data is available. Custom algorithms are developed and maintained to synthesize the data. So why is demand planning so poor in such sophisticated CPG and retail organizations? The answer is three-fold.

First, the relationship between CPG manufacturers and retailers is, on the whole, still combative rather than partnerial, despite all the efforts of Collaborative Planning Forecasting and Replenishment (CPFR) initiatives.

Second, and this is where Auto-ID comes in, it has been too expensive historically to provide accurate inventory levels throughout the end-to-end supply chain. Many retailers provide CPG manufacturers with POS (Point of Sale) data, but few provide inventory data surrounding stock in transit, warehouse/distribution center (DC) stock and the status of that stock (free, reserved, in quality control, etc). Similarly, many CPG manufacturers find it difficult to track inventory through their internal supply chain, especially when product is made in one division, but sold in another – as is often the case in Europe. Providing the ability to track in real time, actual accurate inventory movements "for free" throughout the end to end supply chain, provides an integrated data platform on which more effective demand planning can take place.

Third, bar code-based solutions do have inherent inaccuracy built in due to human error. If anyone throughout the supply chain fails to physically scan, data integrity is lost. Despite the best efforts of operations professionals and bar code system manufacturers, it still requires many different people to physically scan at the right time to maintain inventory accuracy – inevitably this does not happen – which leads to a hazy picture of the supply chain and uncertainty. Inevitably, demand planners build in buffers "just in case" the data is wrong, building in inefficiencies through the supply chain, increasing the risk of unsaleables and increasing paperwork discrepancies.

While Auto-ID technologies do not clear all the fog from the crystal ball of forecasting, they offer a major breakthrough in providing clarity around the current state of product supply – while dramatically reducing the transactional cost to capture real-time, detailed and accurate product supply status data. The key: using Auto-ID technology as an enabler of product status tracking through the supply chain, from source to retail shelf.

Adoption of Auto-ID standards and sharing of information between trading partners can replace the proprietary, inconsistent and incomplete data used by demand planners with accurate, granular and timely data. Increased data accuracy can increase the accuracy of the demand forecast helping CPG companies to achieve "the right product at the right place at the right time".

The costs of uncertainty in today's CPG value chain are clear and significant:
- Higher safety stock levels to combat unexpected shortages
- Longer lead times quoted to hedge against supplier and CPG manufacturer fulfillment surprises
- Excess production and warehousing capacity retained to support surge capacity inventories due to uncertainty about supply status and volatile demand requirements (seasonality, promotion-sensitive)

Depending on the level of implementation, we estimate that a 10–20% improvement in demand plan accuracy could be achieved by CPG companies who use Auto-ID technology. Many factors make the opportunity at each company unique. However, our research indicates that the information quality on inventory levels and product movement that is an integral part of CPFR practices is similar in nature to the inventory information quality that would be available from Auto-ID technology.

Based upon our research and field experience, we conclude that CPG companies implementing Auto-ID technology could deliver the benefits promised by CPFR in terms of forecast accuracy and the resulting supply chain performance improvement. CPFR studies, pilots and implementations have identified forecast accuracy improvements of 10–30% that result in supply chain performance improvements of:

Grocery Manufacturers of America
Accenture CPFR Immersion Day
March 20, 2001

Manufacturer Benefits

a) 5–30% lower inventory levels
b) 2–13% lower warehouse and transportation costs
c) 1–5% higher sales
d) 10–50% reduction in lead times

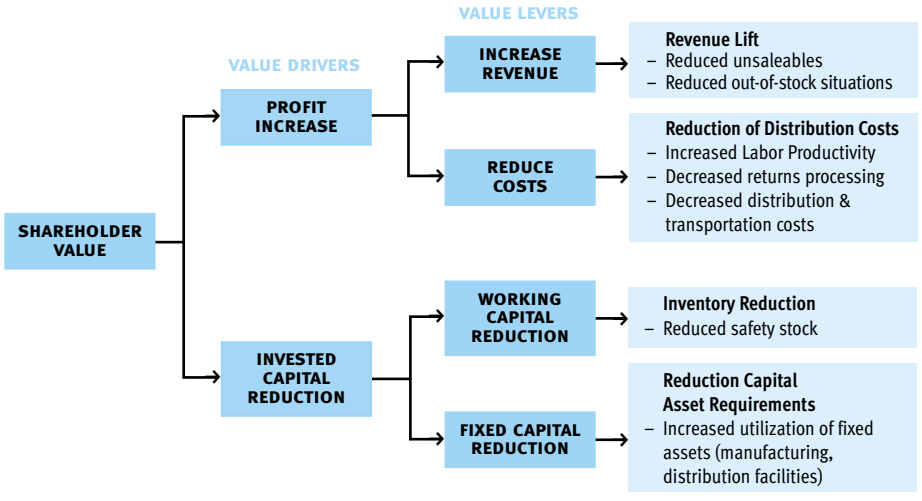
Retailer Benefits

a) 5–8% improvement in store shelf stock rate
b) 5–10% lower inventory levels
c) 2–10% higher sales
d) 3–4% lower logistics costs

This can directly impact shareholder value levers, as shown in Figure 1. Unsaleables, out of stock situations, returns processing, distribution and transportation cost, and safety stock can all be reduced. Labor productivity and asset utilization can both be increased.

Figure 1

SHAREHOLDER VALUE TREE



Consider the following illustrative scenarios that may occur in the near future:

5.1. Ship to Customer Warehouse Scenario

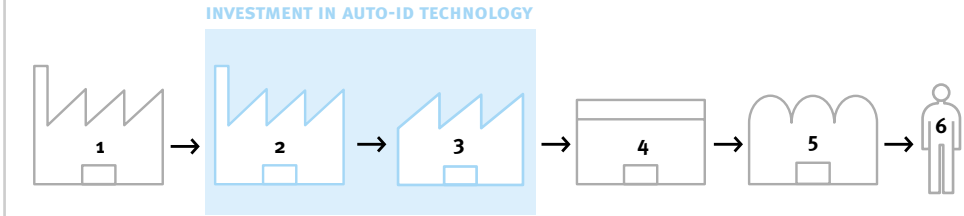
Beauty4U is a manufacturer of cosmetics with annual sales of $4 billion. They sell their product to both retailers and distributors. The highlighted section of Figure 2 identifies the parts of the supply chain where Beauty4U made the investment in Auto-ID technology, selectively placing readers at critical control points in the product flow to improve bar code-based and traditional counting methods of control.

Figure 2:

1. Supplier
2. Manufacturing
3. Finished Goods Distribution
4. Retailer/Distributor Distribution
5. Retail Store
6. Consumer

→ Transport

SHIP TO CUSTOMER WAREHOUSE SCENARIO



Beauty4U has modern manufacturing and distribution facilities where they have implemented pallet and some case level tagging, using Auto-ID technology. There are three manufacturing facilities where Auto-ID "read points" have been installed at each dock door to automatically capture outbound shipments at pallet and case level. Beauty4U has ten distribution centers with an average of ten inbound and ten outbound dock doors. Each of these doors has been equipped with Auto-ID "read points" to automatically and accurately capture receipts from manufacturing facilities and shipments to customers. The demand planning manager of Beauty4U receives sales forecasts by customer from the direct sales force for each period. In concert with this information, the demand planner factors in seasonality (approaching back to school) and planned promotions. This information, along with comprehensive, up-to-date, account level, historical sales volume information available from Auto-ID tracking, is used by state-of-the-market supply chain planning software to generate a demand plan.

Using data from her Enterprise Resource Planning (ERP) system, augmented to a high-precision level of detail by Auto-ID tagging at the pallet level, the demand planner plots her supply status knowing that her finished goods inventory position covers six days of demand against the updated demand plan. Including her production capacity and factoring in lead times, she plans her fulfillment and generates new production orders to cover the balance of the demand plan for the upcoming season and promotion calendar.

Benefits are obtained from the 'certainty effect' on demand planning. Safety stock levels are lowered by 5%, increasing inventory turns and releasing $15 million in working capital. Lead times are cut by one week, as Auto-ID accuracy allows for 'in-time' supply synchronization between production and customer shipment. Sales lift occurs as in-stock positions reach 95%, yielding a 1% increase in sales and generating $40 million in incremental revenue. Unsaleables are reduced by 5%, saving $2.2 million in waste. Also, Auto-ID technology has significantly improved customer service as shipment accuracy approaches 100%. All of these benefits are solely from the supply portion of the total value chain. Additional benefits could be obtained when Auto-ID technology is extended into the demand portion of the value chain.

Looking ahead, she can see how much more precise she can be in her planning. She knows that her company is looking to move to complete case level tagging, and she appreciates that, with the high-value of the branded cosmetic line she is responsible for, the business case for case tagging will be straightforward.

She also envisions moving soon to store-level demand planning – with additional savings and performance improvement. TargX, her largest customer, is investing in standards-based Auto-ID technical infrastructure. This planner knows that she can extend her success in collaborative planning practices with TargX to a new level of performance, as the information quality issues she and her retail trading partner counterparts wrestle with today are resolved by the new level of accuracy enabled by Auto-ID technology. She will be able to share data down to the retail shelf to generate additional shared savings and improved in-stock positions. A manual pilot resulted in 97% shelf-level fill rates and a 55% reduction in average inventories between one CPG manufacturer and a major retailer! All this, without a major change in supply chain management software.

Table 1: Beauty4U Auto-ID Benefits

AREA	CURRENT AMOUNT	%	ADJUSTMENT	AMOUNT	IMPROVEMENT
Finished Goods Inventory	$300,000,000	5%	Decrease	$15,000,000	Working capital
Sales	$4,000,000,000	1%	Increase	$40,000,000	Reducing out-of-stocks
Unsaleables	$45,600,000	5%	Decrease	$2,280,000	Eliminate waste

Table 2: Beauty4U Auto-ID Infrastructure Costs

* Read point consists of frame, antenna, multiplexer, controller, cabling and associated installation

† (HW/SW maintenance, depreciation, support)

CATEGORY	COSTS	UNITS	TOTAL
Initial Tags	$0.40	700,000	$280,000
Reader	$500	215	$107,500
Read Point*	$3,000	215	$645,000
Data Management Software	$30,000	1	$30,000
System Integration	$4,250,000	1	$4,250,000
TOTAL			**$5,312,500**
Recurring Tags & Other Costs†	18%	1	$956,250

5.2 Direct Store Delivery Scenario

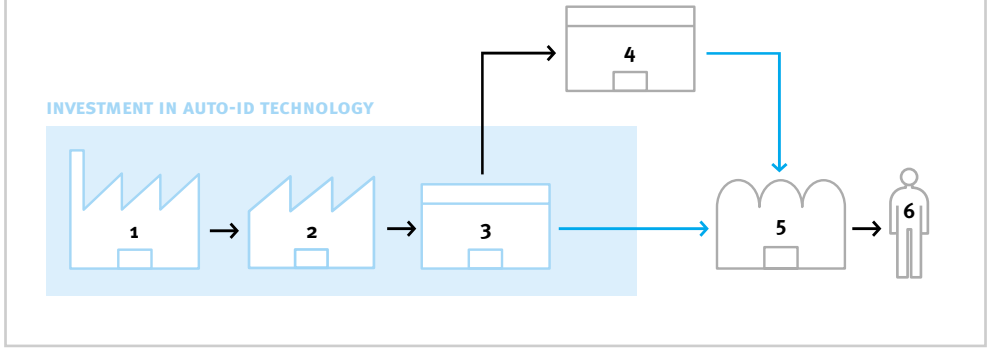
FizzCo is the manufacturer of a branded beverage concentrate with annual sales of $5 billion. FizzCo sells the beverage concentrate to independent bottlers who manufacture and distribute the product. The bottlers network has annual sales of $8 billion. Bottlers distribute directly to off-premise retail outlets. Additionally, they sell their product to other distributors who distribute the product to on-premise retail outlets. The highlighted section of Figure 3 identifies the parts of the supply chain where the company invested in Auto-ID technology, selectively placing readers at critical control points in the product flow to improve bar code-based and traditional counting methods of control.

Figure 3:

1. Brand Manufacturing
2. Bottling
3. Bottler Distribution
4. Retailer/Distributor Distribution
5. Retail Store
6. Consumer

→ Transport/Transfers
→ Direct Store Delivery

DIRECT STORE DELIVERY SCENARIO



FizzCo and the majority of bottlers within the distribution network, have modern manufacturing and distribution facilities where they have implemented pallet and some case level tagging, using Auto-ID technology. The concentrate manufacturer has three manufacturing facilities and distribution centers equipped to tag pallets primarily for lot tracking. However, Auto-ID "read points" have also been installed at each shipping dock door to track the outbound shipments to bottlers. The typical bottler has one bottling facility and four distribution centers. Each location has an average of 10 inbound and 10 outbound dock doors. Each of these doors has been equipped with Auto-ID "read points" to automatically and accurately capture receipts from manufacturing facilities and shipments to trading partners.

Total Auto-ID technology investment: $100 million dollars to equip the entire distribution network. The concentrate manufacturer and each independent bottler absorb the costs for their own portion of the network, spreading the investment burden. Proportionately, the concentrate manufacturer receives a greater share of the benefits. However, the concentrate manufacturer also provides incentives such as geography-specific marketing assistance and promotions as well as direct financial incentives to the bottlers to invest in Auto-ID technology.

With Auto-ID technology, the demand planner can judge the shifting demands for pack, flavor and promotional displays along with the replenishment demand for core brand SKUs that must fill a portion of each truck for each route. As the existing route ordering system captures the product delivery and in-stock information by store/SKU combination, the demand planner factors in high-precision information about distribution center and truck inventory status at the pallet and case level. This squeezes the fulfillment pipeline, eliminating excess safety stock and lower-demand SKUs and accelerating the production/delivery of higher-demand SKUs in the right individual retail outlet locations.

Bottlers will obtain benefits from the increased certainty of their demand plan. The typical bottler may average $1.6 million in sales lift due to 97% in-stock levels, while reducing average inventories by five days. Inventory turns increase by 1.5 turns, exceeding industry averages and freeing $500,000 in working capital. In addition to RSL problems, unsaleables can result from incorrect seasonal or promotion-specific packaging. Unsaleables are reduced to a new average of 0.85% of sales, as store/SKU-level planning precision reaches new levels of accuracy (primarily driven by ensuring that all special promotional packs are sold through). An additional benefit of the Direct Store Delivery (DSD) business: increased sales velocity improves route productivity, lowering sales cost as a percentage of sales. For a bottler/distributor with $100 million in sales, this could yield $2–4 million per year in selling cost savings. Also, Auto-ID technology has significantly improved customer service as shipment accuracy approaches 100%.

The branded concentrate manufacturer obtains a separate complementary benefits stream. The concentrate manufacturer reduces inventories (safety stock levels, lead times) by 5%, reflecting a smaller 'uncertainty' issue in planning the fulfillment of fewer concentrate SKUs into the bottler network. Sales lift of $50 million is derived from the lift experienced by the downstream bottler/distribution network. With unsaleables risk residing at the bottler/distributor, the concentrate manufacturer does not see a benefit stream from this improvement.

Additional benefits will accrue as expensive fixed assets (barrels, containers, etc) used to package and ship concentrate are tagged and managed – reducing cost of lost and damaged assets. Auto-ID enables automated inventory and asset tracking (barrels, totes, pallets, etc) from bottler to retailer, providing 'no-count' high-precision information about the status of inventory and consumption. This aids the CPG manufacturer in planning production and fulfillment into the direct-store-delivery distribution network, while reducing working capital and fixed asset commitments as these expensive capital items are tracked.

The complex DSD distribution network complicates the analysis of the right investment case for Auto-ID technology. The approach taken by the FizzCo bottling network was 'pragmatic continuous improvement'. Moving through high-value 'touchpoints', fixed assets were controlled for quick payback and then leveraged and extended through the network with 'read points' to capture more and more of the revenue at key customer transaction contact points.

Table 3: Concentrate Manufacturer Auto-ID Benefits

AREA	CURRENT AMOUNT	%	ADJUSTMENT	AMOUNT	IMPROVEMENT
Finished Goods Inventory	$375,000,000	5%	decrease	$18,750,000	Working capital
Sales (incremental margin)	$5,000,000,000	1%	Increase	$50,000,000	Reducing out-of-stocks

Table 4: Typical Bottler Auto-ID Benefits

AREA	CURRENT AMOUNT	%	ADJUSTMENT	AMOUNT	IMPROVEMENT
Finished Goods Inventory	$5,000,000	10%	Decrease	$500,000	Working capital
Sales	$80,000,000	2%	Increase	$1,600,000	Reducing out-of-stocks
Unsaleables	$912,000	25%	Decrease	$228,000	Eliminate waste

Table 5: Concentrate Manufacturer Auto-ID Costs

CATEGORY	COSTS	UNITS	TOTAL
Initial Tags	$0.40	250,000	$100,000
Reader	$500	60	$30,000
Read Point*	$3,000	60	$180,000
Data Management Software	$30,000	1	$30,000
System Integration	$2,380,000	1	$2,380,000
TOTAL			**$2,720,000**
Recurring Tags & Other Costs†	18%	1	$489,600

* Read point consists of frame, antenna, multiplexer, controller, cabling and associated installation

† (HW/SW maintenance, depreciation, support)

Table 6: Typical Bottler Auto-ID Costs

CATEGORY	COSTS	UNITS	TOTAL
Initial Tags	$0.40	500,000	$200,000
Reader	$500	100	$50,000
Read Point*	$3,000	100	$300,000
Data Management Software	$30,000	1	$30,000
System Integration	$1,740,000	1	$1,740,000
TOTAL			**$2,320,000**
Recurring Tags & Other Costs†	18%	1	$417,600

* Read point consists of frame, antenna, multiplexer, controller, cabling and associated installation

† (HW/SW maintenance, depreciation, support)

6. THE IMPACT OF CERTAINTY

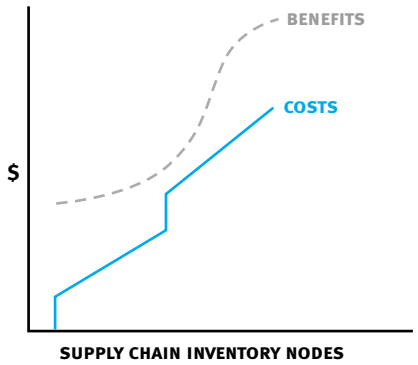
In each scenario, CPG companies invested in the technical infrastructure to track product through their own facilities to their trading partners. This increased order accuracy and provided timely visibility to product movement and inventory levels at a level impossible to achieve using prior practices and technology. Bar code technology has been available for over 20 years now and, theoretically, should enable inventory accuracy at levels greater than currently experienced. However, the required manual intervention and inherent costs will not allow bar code technology to move beyond the current levels of performance.

Auto-ID changes the paradigm, in that data capture is automatic, real time and almost free once the infrastructure is in place. This should enable the supply chain to move to the next level where the described benefits can be obtained. Transponders in-plant, in-warehouse, along with tags on pallets and cases, will track shipments and help reduce the quantity discrepancies during the customer-receiving process, that had previously caused invoice inaccuracy issues.

Figure 4 indicates the relative relationship of the investment required for the Auto-ID infrastructure and the associated benefits as related to the number of nodes in the supply chain, where inventory is retained. A fixed initial amount will be required for infrastructure, along with per unit costs. At some point, additional fixed costs will be required to continue the acceleration of benefits.

Figure 4

COST/BENEFIT RELATIONSHIP



The models presented in this paper provide a simple method to estimate the possible benefits and costs associated with Auto-ID technology. However, please note that calculations of costs and benefits in this document are estimates only. Actual calculations of costs and benefits may differ and will depend upon a variety of factors including the starting point of data accuracy – or certainty – and the rate of adoption within a company and among its trading partners. A rigorous business case must be developed considering additional factors such as product-category specific benefits estimates, a company-specific view of trading partner potential, as well as the specific infrastructure 'map' to optimize value from flow control and the resulting benefits. Many CPG companies will find a large ROI opportunity, once they have collected the specific data and conducted a detailed scenario analysis.

7. INDUSTRY CONSIDERATIONS

In today's operating environment, several challenges confront the progressive CPG manufacturer seeking value from the use of Auto-ID technology in demand planning.

7.1. Technical Infrastructure

The investment in fixed asset infrastructure will be an important one-time investment for CPG manufacturers. Purchasing and installing the hardware (transponders, tags, use-specific readers) is only part of the investment. Modifications to planning software tools to use the resulting high-granularity information must also be factored into the investment. Work will need to be done to review and adjust planning parameters (safety stock levels, display minimums at retail, lead times, economic order quantities) so that the new data is actually driving the planning and decision process. Note that this investment can be offset by the asset reduction benefits of increased inventory turns and asset retirement (warehousing, trucking, plant capacity) as the 'surge capacity premium' is reduced.

7.2. Information Sharing Practices

As the Unsaleables study and other industry research continues to demonstrate – we have a long standing problem concerning CPG manufacturers and their retail trading partners, and it's called "trust". Difficulties in information sharing, leading to lack of information transparency will not be solved by the implementation of Auto-ID technology or any particular technology. If a retailer chooses to limit access by CPG trading partners to in-store inventory and item movement information, then the quality and accuracy of demand planning decisions will be equally limited. Policies and business practices must be addressed by both sides of the trading relationship in order to deliver shared benefits improvements in fill rates, unsaleables and invoice accuracy.

7.3. Product Category Economics

One important observation we have confirmed in our research is that the economics of Auto-ID technology implementation vary significantly by product category. High-value items such as cosmetics, jewelry, apparel, white goods and consumer electronics carry the margin and price point necessary to allow tags at the $.50 level to be added to cases and even sellable items in a cost-effective manner today. Accenture Technology Labs has tested a number of the available and prototype tag technologies, along with sensor technologies and reader/transponder configurations to assess the technical and business feasibility of these solutions with high-value consumer product categories. Several cosmetic manufac-

turers are piloting Auto-ID technology solutions now at the sellable item level. The key understanding is that, depending upon the product category, CPG manufacturers will not move at a uniform pace to implement these technologies. Rather, the pace and degree of extension (container to truckload to pallet to case to sellable item) of Auto-ID technology will be governed by the category in question.

Low-value products (such as dry grocery items) will not initially support an economic model for tagging individual items, even though case and pallet level tracking may well have a strong value case. Our Silent Commerce Cost/Benefit Calculator reflects these differences in our estimating variables. Individual companies must assess their circumstances on a category-by-category basis to arrive at a pragmatic decision about Auto-ID technology.

8. CONCLUSIONS

The problems in demand planning are significant for CPG manufacturers today. Their consequences affect product quality, retailer economics and shopper satisfaction. The potential of Auto-ID technology to improve the certainty of demand planning decision making is equally significant, varying only in the degree of accuracy and detail that is economically appropriate for the product category in question.

The opportunity for CPG manufacturers is here today: to assess the pragmatic benefits opportunities available through demand planning improvement, and to assess the business case for making Auto-ID technology part of the solution. While challenges remain, it is Accenture's view that the progressive CPG manufacturer will take the first step of assessing the business case for high-value product categories and examine the technology options available in today's market. Being an early adopter has its benefits – as improvements in fill rate, inventory turns and customer satisfaction lead to higher sales, higher shopper satisfaction, and better profit margins in a competitive, low-growth CPG marketplace.

9. NEXT STEPS

9.1. Begin with the End in Mind: Investment-Grade Business Case

As technology advances to make the Auto-ID technology systems a reality, CPG companies should begin readying themselves for this transformation. There are a few key activities CPG companies can undertake in order to obtain greater improvements in demand planning.

9.2. Identify Opportunities

Consumer products that carry high value, require controlled manufacturing and distribution and feature collaboration between trading partners, will be areas to begin implementation of Auto-ID technology in the near term. We anticipate that pallet and case level tagging will be cost effective for these product categories.

We believe tagging individual consumer goods at the item level will not be cost effective in the near term for the majority of fast moving consumer goods. However, detailed cost-benefit analyses and business cases for specific applications will be required to evaluate the unique situation of each company.

Retailers will continue to be unable to provide accurate SKU level inventory information for some time and will continue to be hesitant to share this with CPG companies when it is available. Therefore, infra-

structure efforts should be focused on two areas: intermediate control points within the CPG supply chain and encouraging Retailers to adopt Auto-ID technology to provide a similar level of visibility and accuracy.

9.3. Determine Deployment Models

Companies should design the solutions to minimize the required investment using techniques such as multi-protocol readers and reusable tags, within concentrated segments of their supply chain. To maximize possible benefits, companies will need to share information with their trading partners. Companies will need to determine if information will be shared with select partners or whether the application will become an industry standard that offers all participants similar information. The proprietary nature of the information along with the relative costs and benefits of deployment through private systems, consortia, or third-party service models must be considered through a fact-based modeling process. Based on this analysis, they can select the model that best meets their organization's benefit requirements and deployment criteria. Most applications will be private closed system solutions in the near term. Over time, however, third-party solutions are expected to become more prevalent as the technology community commercializes Auto-ID standards.

9.4. Build Pilots to Test and Refine Deployment Models

A first step toward the deployment of systems is to build a pilot application to test and refine hypotheses about benefits, costs and work processes after implementation. As CPG companies continue to improve their demand planning capabilities through new systems and processes, they should look for opportunities to include Auto-ID technologies in controlled pilots. Pilot applications are vital to provide a realistic assessment of the application's potential benefits as well as the key process changes required for implementation. These pilots will allow a CPG company to explore how the technology can be used to improve processes and to identify requirements for integrating with legacy applications and processes.

Pilots are "best practice" for learning how to effectively realize value from Auto-ID technologies. Conducting pilots early can give companies insights into issues or additional ways that specific operations and processes can be improved. Learning that takes place before full-scale deployment can help companies refine their business cases for specific applications, select the most productive applications and lower overall implementation costs.

9.5. Scale Volumes to Grow the Benefits

Where pilot tests show promise, the next step is to scale the deployment of the technology. Major retailers are actively pursuing Auto-ID technology. CPG companies must be prepared to meet the requirements of the channel masters in order to become or continue their current status of preferred supplier.

Successful Auto-ID take-up will be comprised of several stages in an overall adoption journey. Accenture has utilized this approach and delivered innovations to numerous clients. We recommend that you consider the following stages:

- Business case value targeting and opportunity alignment
- Deployment model selection
- Piloting
- Integration with existing systems
- Implementation at scale and across trading partners – open systems

We have over 300 professionals in our dedicated Accenture Supply Chain practice who are focused on assisting clients in implementing leading edge practices and emerging technologies to achieve these types of benefits. In the CPG industry we have recently focused on practically applying CPFR as a particular type of advanced demand planning technique. In concert with the promise of Auto-ID technologies, we see CPFR as being a breakthrough value creator for early adopter CPG companies.

10. APPENDIX

10.1. Auto-ID Primer

Introduction

Auto-ID technology consists of several parts: eTag – an electronic tag, 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 5).

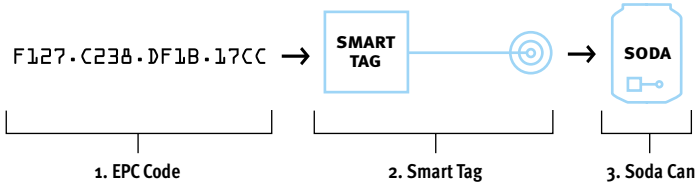
Figure 5:

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. RFID 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 RFID technology; any way of being able to quickly and easily read a unique ID from a product will work. RFID 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 6).

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™.

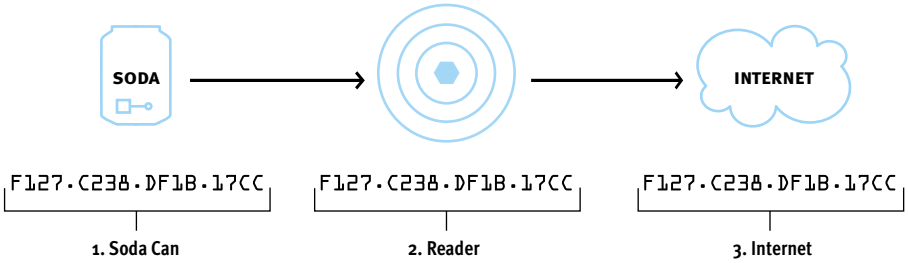
Figure 6:

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 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 sources of incremental revenue. New services will start to emerge as objects start to become smart and interactive. As the technology becomes pervasive, benefits will 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 will interact with manufacturers, their trading partners and each other to form an optimally efficient cycle of direct, real-time supply and demand.

10.2. 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% of the time. Environmental issues, the make-up 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.

RFID 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 RFID, 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. Sub-second 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 RFID uses unlicensed RF spectrum, the available spectra that is usable for RFID 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 Industrial, Scientific and Medical (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 read 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.

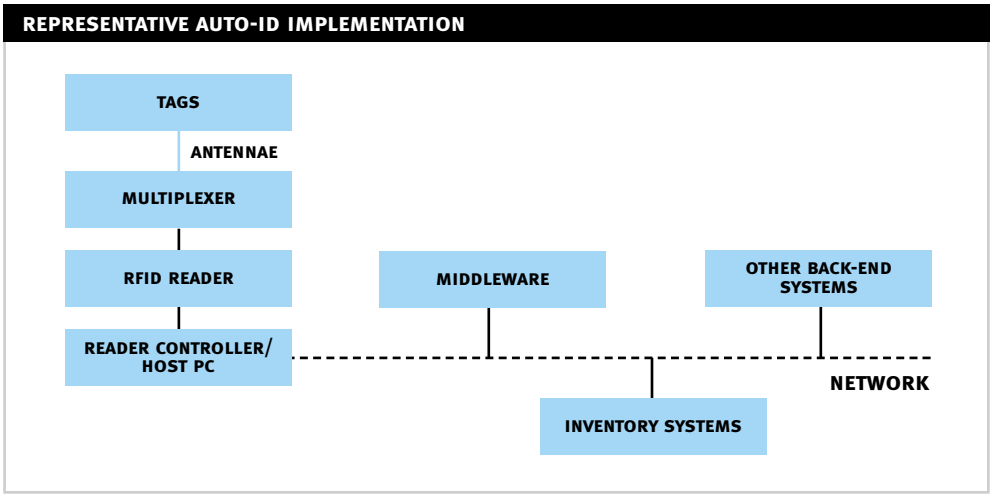
Privacy
Finally, a large, mostly perceived risk in Auto-ID, falls within the area of privacy concerns. The idea of tracking products into the home is troubling to most concerned parties. Consumer fears in this area are sparked by a lack of understanding of the limitations of RFID. Education is the key 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 EPCs™ 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.

10.3. The Elements of Cost

The Basics of Cost
Radio frequency identification (RFID) 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 7 gives a schematic of the various components of an Auto-ID system roll-out. This section outlines each of these components and offers recommendations to calculate the overall cost in a business case for Auto-ID.

Figure 7



Tag Costs

RFID **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 fifty 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 pre-assigned 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/RFID 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 $2500 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 $2000 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: $1000 to $3000 USD.

Tuning

Another cost in an RFID 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), 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% 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 inter-company 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.

11. REFERENCES

1. **Unsaleables Update.**
   Volume 2 Number 3, Food Marketing Institute, Summer 2002

2. **Grocery Manufacturers of America Invoice Accuracy Best Practices Study.**
   Accenture, 2001

3. **Full Shelf Satisfaction: Reducing Out-of-Stocks in the Grocery Channel.**
   Grocery Manufacturers of America, 2002

4. **Where to Look for Incremental Sales Gains: The Retail Problem of Out-of-Stock Merchandise – A Study conducted by Andersen Consulting for the Coca-Cola Retailing Research Council.**
   Accenture, January 16, 1996

5. **Grocery Manufacturers of America**
   Accenture CPFR Immersion Day, March 20, 2001

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