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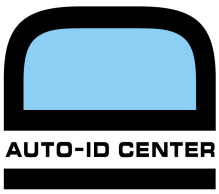

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Auto-ID Across the Value Chain: From Dramatic Potential to Greater Efficiency & Profit

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ABSTRACT

Next-generation automatic identification (Auto-ID) technologies currently in development and testing by the Auto-ID Center promise to provide a wide range of business benefits in many industries. In addition to enabling improvements within companies, low cost, open-standards-based Auto-ID infrastructure has the potential to track materials, goods, and assets across the value chain. In the near future, companies will use this timelier, more accurate information to collaborate more effectively and achieve new levels of efficiency and responsiveness. Based primarily on interviews of Auto-ID Center sponsor companies, Accenture clients – and an analysis of prior pilots and cross-industry initiatives – this document identifies:

- Potential business benefits of next-generation Auto-ID technologies across a range of value-chain activities
- Important technical and business issues affecting Auto-ID deployment
- Likely scenarios for the deployment of Auto-IDs in the consumer packaged goods (CPG) value chain
- Various business models for Auto-ID deployment for benefits across the value chain

We conclude that early corporate Auto-ID initiatives will seek proprietary benefits. To gain the significant benefits promised by improved supply chain visibility and inventory reductions, however, companies will need to go further, taking steps over time to collaboratively migrate to open systems and shared applications.

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Biography

by Ajit Kambil
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Ajit Kambil leads a number of research projects at the Accenture Institute for Strategic Change related to supply chains, electronic markets, innovation, and venturing strategies. Dr. Kambil has undergraduate and graduate degrees from MIT, including his Ph.D. in information technologies. Before joining Accenture, Dr. Kambil was on the faculty of New York University's Stern School of Business where he was a principal investigator on a National Science Foundation funded project to put the Securities and Exchange Commission's EDGAR database on the Internet. His research has been published in distinguished journals including Harvard Business Review, Sloan Management Review, Management Science, the Journal of the American Society of Information Systems, Communications of the ACM, and IEEE Computer.

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Jeff Brooks' work at the Accenture Institute for Strategic Change focuses on business-to-business electronic commerce, and supply-chain innovation. Dr. Brooks earned undergraduate degrees in mathematics and psychology from Wake Forest University and his Ph.D. in psychology from the University of North Carolina at Chapel Hill. Prior to coming to Accenture, he earned his MBA and MS-MIS (Management of Information Systems) degrees from Boston University's School of Management, where his research focused on knowledge management. His business and academic writings have appeared in industry journals and Achieving Supply Chain Excellence through Technology.

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Contents

1. EXECUTIVE SUMMARY

In a significant evolutionary step forward from today's widespread use of Universal Product Codes (UPC) and barcodes for automatic identification, or Auto-ID, important new technologies are being developed that will extend the enterprise's ability to capture accurate information about the location and status of physical objects across the value chain. Companies in many industries are now investigating the potential for electronic product codes (EPCs) and radio frequency identification (RFID) technologies – the Auto-ID technologies of the future – to create significant new benefits for their individual operations and collaborative value-chain activities.

The Auto-ID Center, which is sponsored by a growing list of more than forty companies and organizations from various industries, conducts research, builds consensus and supports industry-wide standards to promote the development and adoption of next-generation Auto-IDs. Based on preliminary business case development interviews with executives from manufacturers, logistics service providers and retailers in the consumer packaged goods (CPG) industry, the Center has identified key issues that must be addressed for companies to realize the full economic benefits of Auto-ID technologies. While this paper focuses on the CPG industry to explore Auto-ID deployment issues and dynamics across a value chain, we expect that similar conditions and challenges will exist in every industry.

Interviews with CPG leaders have revealed the following key insights:

- Industry-leading companies will gain measurable business advantage by reducing inventory and out-of-stock scenarios at critical points in the value chain, and will further improve results by becoming increasingly responsive to shocks in supply and demand.

- The most significant supply-chain benefits will be enabled by shared implementations across organizational boundaries.

- Despite the larger benefits of shared implementations, companies will initially develop focused applications that offer proprietary benefits and are easier to justify internally.

- As tag costs diminish, value will migrate from tagging shipping pallets to tagging cases to tagging individual items. Consumer goods manufacturers will likely employ case-level tagging to track products across the value chain and will gain significant benefits from these efforts. Retailers, in contrast, will gain greater benefit by leveraging the ability of item-level tagging to improve valuable in-store operations.

- Important issues companies must address before they can realize value from Auto-IDs include the upfront costs of deploying readers, of purchasing (and/or developing) software to capture reader information, of ensuring the ability for technologies to scale as data requirements grow, and of integrating new hardware and software with existing systems operated by numerous companies across the value chain.

- A number of viable business models will likely enable Auto-ID deployment depending on the expected kinds – and levels – of proprietary versus shared benefits.

- Companies will not accrue the full value of shared benefits from Auto-ID unless and until their industries develop a consensus on an appropriate business model (or models) for deploying Auto-ID systems.

2. A BRIEF INTRODUCTION TO AUTO-IDS

From barcodes to smart cards, automatic identification (Auto-ID) technologies are now widely used in almost every industry. Their applications range from access and security systems to systems for item tracking, inventory management and simplified checkout at retail stores. Auto-ID originated with the development of barcode readers (1952), barcodes (1966) and the Universal Product Code, or UPC (1973).

The ubiquity of UPCs and barcodes has made a dramatic impact on the consumer packaged goods (CPG) industry, which includes the manufacturers and retailers of consumer goods and services. By leveraging barcode and UPC technologies, the grocery industry, for instance, was able to realize hard and soft savings (as percentages of revenue) of 2.76% and 2.89% respectively. By 1997, the industry estimates that these hard and soft cost reductions added up to approximately $17.0 billion in total annual savings taken from every area of its end-to-end value chain – starting at production and ending on the store shelf. [1]

Today's developing Auto-ID technologies, in particular electronic product codes (EPCs) and radio frequency identification (RFID) tags, will deliver significantly higher hard and soft savings across industries. This new technology upgrades the ability to automatically identify objects through UPCs and barcodes, providing more accurate, specific and timely data while reducing or eliminating the labor involved in capturing Auto-ID information. This higher quality information will allow companies to track individual objects across the value chain, increasing the efficiency of individual processes, improving asset utilization, increasing the accuracy of forecasts, and improving the ability of companies to respond to changing conditions of supply and demand.

How do new Auto-ID technologies offer such compelling potential?
By embedding physical objects with an intelligence that allows them to communicate with a new generation of business applications that manage supply and demand in real time, Auto-ID technologies could revolutionize how we manufacture, buy and sell products. In doing so, Auto-ID technologies will likely offer companies billions of dollars in savings, while enabling them to meet customer needs more quickly and directly.

Here's how Auto-ID technologies work[2]:
Individual physical objects are identified with a 96-bit electronic product code (EPC) stored in memory chips known as "smart tags." The EPC can uniquely identify more than 268 million manufacturers, each with more than one million products, with enough numbers left over to tag all the individual consumer products manufactured for the foreseeable future. The smart tags – which are attached to, or embedded in each object – have antennae that allow them to communicate wirelessly to other devices.

[1] **Haberman, Alan L.**
Editor, Twenty-Five Years Behind Bars, Harvard University Press, Cambridge, MA, 2001, p. 143

[2] **Auto-ID Center web sites:**
http://autoidcenter.org/technology.asp
http://autoidcenter.org/technology_transmitting.asp
http://autoidcenter.org/technology_applications.asp
http://autoidcenter.org/technology_reinventing.asp

The text in this section is adapted primarily from information contained the web pages listed above. The authors shortened and paraphrased the web content for this paper, but the ideas that inform the explanation remain the Auto-ID Center's.

AUTO-IDS GIVE EACH OBJECT AN UNIQUE IDENTITY

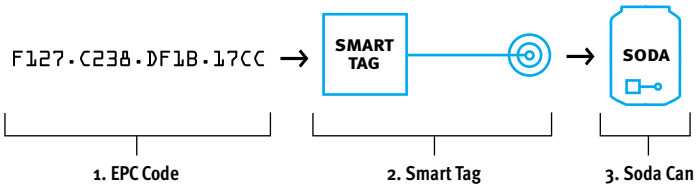


Figure 1:

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"

Strategically placed wireless radio frequency "readers" scan the smart tags and transmit an object's embedded identity code to the Internet, where more detailed information on the object is stored. That information can then be communicated back from the Internet to provide manufacturers, suppliers, logistics service providers or retailers whenever information is needed about that object. Scanners on store shelves, for instance, could alert managers to perishable items that have passed their freshness dates.

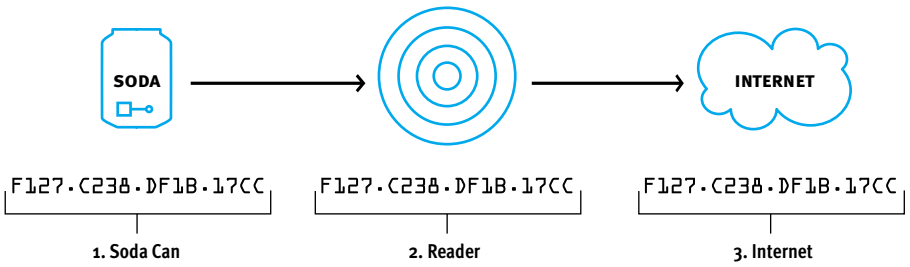
Figure 2:

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

AUTO-IDS CONNECT EACH OBJECT TO ITS UNIQUE INFORMATION



On the Internet, the EPC works together with an Object Naming Service (ONS) and a Product Markup Language (PML). The ONS tells computer systems where to find information about any object that carries an EPC code. The ONS is similar to the Internet's existing Domain Name System (DNS), which routes information to appropriate web sites, but it will likely be many times larger, locating data for every one of the trillions of objects carrying an EPC code. The PML is a new standard "language" for describing physical objects in the same way that HyperText Markup Language (HTML) is the common language that tells web browsers how to display most Internet web pages.

Taken together, Auto-ID technology merges bits and atoms together to form one seamless network that allows everyday objects to interact intelligently with people and organizations in real time.

3. CREATING OPPORTUNITIES: AUTO-ID COSTS, STANDARDS & VIABILITY

The Auto-ID Center is looking to EPCs and RFIDs together to become the next ubiquitous Auto-ID system that will provide expanded opportunities to save money and generate revenue across the value chain. To make good on that promise, however, this new technology will need to overcome several barriers to widespread adoption at scale.

Currently, RFID tags are readily available from various vendors, but the technology is fairly expensive and proprietary. Low-end tags sell at about forty cents a tag, while low-end readers cost between three hundred and five hundred dollars. In contrast, barcodes cost about one cent, and barcode readers can be had for as low as one hundred and twenty dollars. The Auto-ID Center is working with sponsor companies to make RFID a potentially viable alternative to barcodes by enabling the development of RFID tags that cost five cents or less at high manufacturing volumes[3]. They are also developing open standards for readers that they expect will promote lower prices by increasing direct competition among vendors.

[3] **Sarma, Sanjay**
"Towards the 5-Cent Tag."
Auto-ID Center White Paper
MIT-AUTOID-WH-006, 2001.
See http://www.autoidcenter.org/pdfs/MIT-AUTOID-WH-006.pdf

Beyond keeping prices high, proprietary technology from vendors inhibits the use of tags and readers across multiple applications. At present, most vendors' RFID technologies are incompatible with other vendors' software and hardware offerings. While there are some groups of vendors that offer compatible products, major CPG companies believe RFID technologies will not enjoy widespread adoption until multi-use RFID technology based on open standards is adopted.

In addition to a standard RFID technology set, the new Auto-ID system depends on the adoption of a standard code for identifying individual objects. Currently, the Uniform Code Council (UCC) and the EAN International (originally known as the European Article Numbering International) subscribe to a set of numbering standards based on a Global Trade Item Number (GTIN). The GTIN uniquely identifies types of trade objects (e.g., different products or services, cases of particular products), but cannot distinguish between individual items of the same type. The proposed EPC standards, in contrast, would use a globally unique serial number to identify each individual trade object (not just what type it is) that could then be used to access item-specific information residing on the Internet. As with the hardware infrastructure for RFIDs, the Auto-ID Center is working with sponsor companies and organizations (including the UCC) to define how the EPC will be implemented in the RFID technology [4] and how the associated software and information services should operate [5]. To encourage adoption, the EPC system is being designed to map consistently to standards that are already in place and to integrate with legacy applications based on the GTIN [6].

[4] **Brock, David L.**
"The Compact Electronic Product Code." Auto-ID Center White Paper MIT-AUTOID-WH-008, 2000.
See http://www.autoidcenter.org/pdfs/MIT-AUTOID-WH-008.pdf

[5] **Sarma, Sanjay; Brock, David L. and Ashton, Kevin**
"The Networked Physical World." Auto-ID Center White Paper MIT-AUTOID-WH-001, 2000.
See http://www.autoidcenter.org/pdfs/MIT-AUTOID-WH-001.pdf

[6] **Brock, David L.**
"Integrating the Electronic Product Code (EPC) and the Global Trade Number (GTIN)." Auto-ID Center White Paper MIT-AUTOID-WH-004, 2001.
See http://www.autoidcenter.org/pdfs/MIT-AUTOID-WH-004.pdf

4. TARGETING VALUE: FROM VALUE CHAIN TO PROFIT CHAIN

Novel Auto-ID applications can create significant opportunities for companies in many industries to deliver value to their organizations. Today a number of companies are using RFID business applications or piloting the technology to realize or evaluate benefits. At present, these efforts don't rely on EPCs, instead employing proprietary RFID technologies to obtain company-specific operational benefits.

A few examples:

- A major consumer goods company uses RFID tags to track materials through the production process, ensuring that the sequence and timing of manufacturing steps are correct and that better quality products result from existing manufacturing processes [7].

- Goldwin Sportswear Europe, the European branch of one of the largest branded sportswear companies in Japan, has piloted the use of RFID tags on individual clothing items to track shipments, prevent unauthorized out-of-area distribution and authenticate products [8].

- CHEP, a provider of pallets and containers and a sponsor of the Auto-ID Center, is piloting an RFID system to track its pallets to improve how it uses and manages its assets [9].

- Associated Food Stores, a cooperative of over 500 supermarkets in the western United States, uses an RFID-based real-time locating system at its distribution center to improve yard management. The system allows yard managers to know when trucks or trailers enter or leave the yard, where these assets are located in the yard along with their status – a temperature spike would indicate, for example, that a refrigerator unit's door was left open [10,11].

- Prada, the fashion house, is using RFIDs in its Epicenter store in New York City to enhance the shopping experience with kiosks that give customers access to product information such as cut and fabric details, designer sketches and runway demonstrations in addition to suggestions on accessories or alternative products [12].

[7] Accenture case study.
Client name is confidential.

[8] Texas Instruments press release, "TI's RFID Smart Labels track leading brand sportswear through Production, Shipping, and Distribution – and reduce Shrinkage and 'Grey' Importing," 2001.
See http://www.ti.com/tiris/docs/news/news_releases/rel3-20-01.htm

[9] Interview conducted in 2002 with Michael Archer reflecting on CHEP's corporate perspective on – and use of – RFID technologies.

[10] **Songini, Marc**
"IT Plays Radio Tag," ComputerWorld, April 8, 2002.
See http://www.computerworld.com/itresources/rcstory/0,4167,STO69884_KEY258,00.html.

[11] **Songini, Marc**, ibid.

[12] Texas Instruments press release. "Prada Personalizing Customer Experience at New York Epicenter Store Using Texas Instruments RFID Smart Labels," 2002.
See http://www.ti.com/tiris/docs/news/news_releases/rel4-23-02.shtml

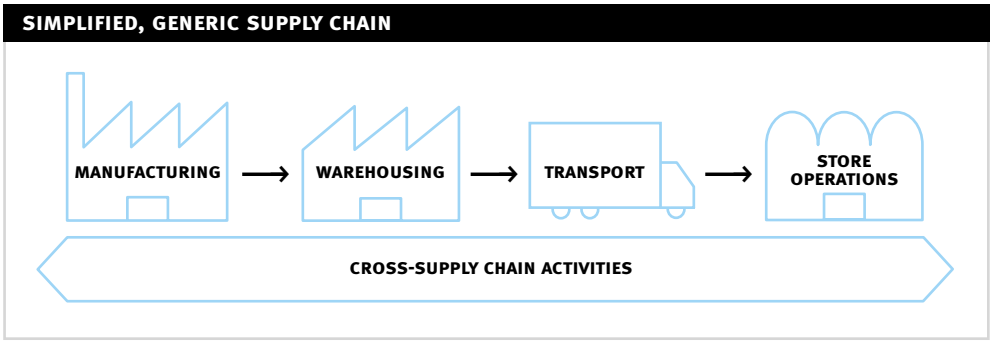
– Ford uses an RFID system in its automobile assembly plants to request parts replenishment to the line and help forklift drivers deliver those parts more quickly and efficiently [13].

– An oil and gas refinery in the UK is using an RFID system to assist with monitoring and maintaining pressure safety relief valves in vessels, pipe work and process equipment, reducing the re-certification and repair cycle time by up to 64% as compared to manual methods[14].

Numerous other examples of proprietary RFID use exist across business functions, industries, and public and government agencies. But as EPCs and open standards RFID technology become available, it is increasingly possible to foster the adoption of interoperable Auto-ID systems. While companies can selectively cooperate to establish a joint application based on proprietary Auto-ID systems, organizations require interoperability to gain benefits that involve the activities beyond those of a few key partners. The transition to interoperable systems presents companies in every industry with a new range of Auto-ID options along the entire value chain (see Appendix: Auto-ID Across the Value Chain). Lower cost and open-standards-based infrastructure can make individual applications more economically attractive while enabling cross-value-chain applications that simply are not possible when standards fail to apply across company boundaries.

The following discussion of the potential uses of Auto-ID applications by manufacturers, logistics providers and retailers is built around a simplified view of the supply chain:

Figure 3: Simplified view of supply chain



All companies in the value chain are concerned with cross-supply chain activities that track items or provide forecasts or actual supply and demand signals. While manufacturers, by definition, concern themselves with manufacturing processes, they typically go further, warehousing materials and finished goods and managing transportation of products to customers. Logistics services providers focus on distribution activities related to warehousing and transportation. Retailers also oversee multiple activities, often engaging in management of their own distribution centers, the transportation of goods to stores and, of course, the operation of their stores.

Below we focus on the CPG industry vertical as a primary domain to explore the issues and dynamics of deploying the new Auto-ID technologies across a single value chain. As it did with barcodes and UPCs, the CPG industry is driving the development and adoption of the new Auto-ID technology; fostering Auto-ID adoption in this important industry is crucial to widespread acceptance of Auto-IDs. We expect, however, that many of the issues identified for the CPG industry will be relevant for any industry investigating the use of Auto-IDs.

[13] "Ford: Asking for Parts Replenishment – Electronically." Frontline Solutions, February 2001. Available at: http://www.frontlinemagazine.com/rfidonline/c-s/1008.htm

[14] "Oil refinery checks valves safely and accurately with RFID tags," Frontline Solutions, February 2000. See http://www.frontlinemagazine.com/rfidonline/c-s/1005.htm

4.1. Manufacturers and Auto-IDs

CPG manufacturers face a number of key business challenges:

1. Moving into global markets to expand out of saturated traditional markets
2. Improving top-line growth by creating new products that tap into latent customer needs
3. Improving operating margins and pricing in an environment where retailers have increasing power and price rivalries are intense

Auto-ID technologies address the latter challenge by leveraging the ability of EPCs and RFIDs to deliver cost reductions, revenue growth and improved supply-chain performance.

The operational context for CPG manufacturers is worth exploring. Manufacturers manage complex end-to-end supply chains, including complex distribution systems and disparate demand patterns. Their facilities produce millions of individual items per year with thousands of SKUs in dozens of product categories. Production inputs vary widely from commodity and specialty chemicals to manufactured parts and a variety of packaging materials. Products flow from factories to manufacturers' own distribution centers or wholesaler or retailer distribution centers, moving eventually (or directly) to specific retail stores and store shelves. And to make matters even more intricate and interdependent, many product categories vary on overall demand, seasonality, and the ability of marketing and promotions to create demand spikes or out-of-stock positions on retail shelves.

Some CPG manufacturers already use collaborative forecasting and demand planning with their major retail customers to balance anticipated supply and demand. More accurate and timely demand signals from customers and consumers, however, could help manufacturers reduce inventories, increase responsiveness, reduce out-of-stock positions and, perhaps, even optimize capacity.

CPG manufacturers can realize proprietary benefits from Auto-ID applications for production processes, but leading manufacturers tend to have sophisticated process control systems already in place, making the marginal benefits of new Auto-ID-based systems less attractive.

Executives of several leading CPG manufacturers indicate that their companies' major priorities for Auto-ID technology are to:

- Lower inventory and distribution costs across the value chain through better supply chain visibility and demand planning
- Achieve significant inventory reductions and more efficient distribution
- Leverage improved demand visibility to become more responsive to changing customer wants and needs
- Decrease theft and counterfeiting for high-value items

Manufacturer analyses of different opportunities suggest that many of their desired benefits can be achieved with case-level tagging. Industry leaders also recognize that the full potential of these benefits can be gained only with widespread adoption of EPCs and open-standards-based RFID systems throughout the industry value chain.

The need for widespread adoption before large value-chain benefits can accrue means that leading companies may need to accept smaller benefits for some time after implementing new Auto-ID systems. In addition, most manufacturers' internal systems aren't as advanced as those of recognized industry leaders, which is why we expect these follower firms to focus on proprietary applications that can drive immediate, firm-level benefits. Followers are also less likely to be moved by a long-term, strategic vision for the Auto-ID-enabled supply chain and are more likely to wait for industry leaders to prove the feasibility of the inter-organizational applications before implementing these applications themselves.

4.2. Logistics Services Providers and Auto-IDs

Logistics services providers, including asset aggregators who provide supply-chain components such as reusable pallets and shipping cases, are primarily interested in applications that can improve asset utilization, reduce delays and increase responsiveness. These applications focus on asset tracking, asset utilization and dynamic optimization. In addition, logistics services and asset providers may offer enhanced shipment tracking to their customers, providing data on the location and status of products as they move from manufacturers to retailers.

Given the potentially high levels of proprietary benefits from improving asset tracking and utilization, we expect many logistics providers, the critical intermediaries between manufacturers and retailers, to play a vital role in the diffusion of Auto-IDs in inter-organizational applications. We expect many logistics providers to implement Auto-IDs to improve asset management: Tagging shipping containers, for example, would allow logistics providers to use these container assets as vehicles for sharing tracking information with buyers and suppliers who, at any given time, need to know exactly where their products and materials are.

4.3. Retailers and Auto-IDs

CPG retailers face these primary business challenges:

1. Keeping their format “fresh” so that they remain relevant to the consumer
2. Providing vehicles for growth beyond opening more stores by, for example, inventing new formats, expanding internationally, or making acquisitions
3. Relentlessly driving greater efficiencies from the business

Auto-IDs address the latter challenge by tracking products and assets and ensuring that product information can be shared.

For many retailers, mastery of increasingly complex supply chains is a differentiating factor for improved financial performance. As retailers manage the flow of goods from a thousands of vendors and source points to meet wide swings in seasonal and/or fashion demand, retailers’ ability to precisely track their inventory and supply chain assets will be a major driver of operational benefits enabled by Auto-IDs.

The following underlying capabilities will serve as a foundation for retail applications:

A. Product Tracking
Auto-IDs will provide retailers with unprecedented views of product inventory at both macro and micro levels. At the macro level, a network of readers employed by trading partners across the supply chain will make products visible whether they’re at a store, in transit, at a consolidator or in a distribution center. At the micro level, specific product occurrences can be located within the store.

B. Product Information-Sharing
Individual EPCs will be associated with critical retailer-required information accessible via the Internet. Information about each individual product occurrence can be used to better manage warranty and post-sales service programs.

C. Asset Tracking
Consumer products that move through the supply chain can be made visible and located. The other assets that facilitate product movement, such as shipping containers, trailers and totes, can also be made visible and located, resulting in better joint utilization of items and assets.

Unlike manufacturers, retailers are primarily interested in focused Auto-ID applications – especially those relevant to store operations. These applications can bring retailers significant benefits, including an increased ability to manage in-stocks, fraud, and presentation, resulting in increased sales and reduced costs. In addition, automating consumer-facing processes, such as checkout and returns/ warranty authentication, have the potential to improve the shopping experience and customer loyalty.

5. PAYING ATTENTION TO DETAIL: DEPLOYMENT ISSUES

Manufacturers and logistics services providers envision that the primary benefits of Auto-ID technologies will revolve around applications that cut across the value chain and different businesses. Retailers are more focused on Auto-ID applications that would bring them proprietary benefits, but most of these applications are dependent on item-level tags that manufacturers would affix to their products. Given the different goals and interconnected needs of manufacturers, logistics providers and retailers, widespread Auto-ID adoption will require all three groups to arrive at consensus on ways to face a variety of technical, economic and business issues that may impede effective deployment.

5.1. Technical Issues

Large-scale EPC and RFID deployment confronts a number of technical issues across the four key components of business systems:

- Tags and readers
- Data management and network Services
- Applications
- Integration software and services.

Tags and Readers

Widespread EPC adoption depends on open-standards-based RFID systems that will function across a range of potential environments and applications. Technical requirements of the RFID systems may constrain the specific applications they can support. These constraints affect several key elements of system design such as [15]:

FREQUENCY: To support ubiquitous, nonproprietary use, the new RFID systems must operate in free areas of the wireless communications spectrum across the regulatory boundaries of countries and global regions. The choice of frequency affects the physical design and size of antennae, the effective read-range between readers and tags and possible interference between RFID systems and other electronic devices. The Auto-ID Center is exploring the option of designing "agile" readers to address the potential need for systems to operate at different frequencies across boundaries or in various physical environments (see below).

PHYSICAL SPACE: The RFID system's physical layout and the surrounding environment must support communication between tags and readers. The radio signal from proposed low-cost tags is relatively weak and can be limited to a range of a few centimeters up to several meters. Adding a miniaturized battery to improve signal strength may be appropriate in some situations, but their relatively high cost is impractical for the ubiquitous tagging envisioned for consumer products EPCs. Larger antennae can also increase the range and quality of the signals from tags, but these cost more and may not fit on small items. In addition, interference from water, which absorbs radio waves, and metal, which can

[15] **Scharfeld, Tom** "An Analysis of the Fundamental Constraints on Low Cost Passive Radio-Frequency Identification System Design." Master's Thesis, MIT, Cambridge, Mass., 2001. Available at http://autoidcenter.org/research/TAS-MSThesis-Final.pdf

reflect radio waves, can degrade the signal, reducing the tag's readable range and, in extreme cases, preventing tag-to-reader communications.

THROUGHPUT: RFID systems, while fast and automatic, cannot read tags instantaneously. Tags in close proximity to one another – on store shelves or in packing cases, for example – can respond to a reader's query simultaneously, resulting in an unintelligible cacophony of received signals. Similarly, readers placed too close together can scramble each other's attempts to read tags wherever reading ranges overlap. Protocols are being developed to address these "signal collisions", but these protocols slow the rate at which tags can be read [16, 17]. The upshot is that it may be possible to read tags on dozens of items in a grocery cart as a consumer leaves a checkout, but it may be impossible to avoid unacceptable lag times when hundreds of items on a pallet are loaded onto a truck.

[16] **Engels, Daniel W.** "The Reader Collision Problem." Auto-ID Center White Paper MIT-AUTOID-WH-007, 2001. See http://www.autoidcenter.org/pdfs/MIT-AUTOID-WH-007.pdf.

[17] **Law, Ching; Lee, Kayi and Siu, Kai-Yeung** "Efficient Memoryless Protocol for Tag Identification." Auto-ID Center White Paper MIT-AUTOID-TR-003, 2001. See http://www.autoidcenter.org/research/MIT-AUTOID-TR-003.pdf.

Data Management and Network Services

Widespread Auto-ID deployment will require a new breed of data management and network services. As RFID readers interrogate numerous tags at multiple points in the value chain, they will generate substantial volumes of item-level EPC data that needs to be processed and communicated across the value chain.

Data management software is required to:

- Capture data from readers
- Manage data storage
- Aggregate data
- Make data meaningful by processing it into useful information and reports.

Given the limited item attribute information embedded in the EPC itself, data management software is also required as a layer between the reader and network-based object naming services for providing data such as price, expiration and other item-oriented information. Data management services will also play key role in transferring critical data to applications such as those used for demand management, inventory control and forecasting. Today, data management services that scale to simultaneously track millions or hundreds of millions of items in real time are still in their infancy and the scalability of these services remains unproven.

Similarly, network requirements for transferring data from readers to applications and communications requirements for accessing information that complements EPCs are uncertain. Depending on the application, it may only be necessary to transfer minimal EPC information when, for example, a retail store sends in daily readings of pallet tags. In other situations, large amounts of item-oriented information may need to be transferred, say, from store shelves to product information databases to consumers – if, that is, individuals can request specific information on items being considered for purchase. Given that particular applications have not yet been designed, it is still unclear what new communications infrastructure will be required for widespread EPC adoption.

Applications

The third key technical component required to realize value from EPCs are applications that use EPC and item tracking information to create business value. These may be new applications for scheduling and workflow management within manufacturer, retail and logistics companies or applications that cut across corporate boundaries such as those for order management and collaborative forecasting and replenishment. Other applications include asset tracking, utilization and optimization software along with warehouse management, process control and quality assurance systems.

As various interviewees noted, existing applications, including checkout, inventory management and enterprise systems, were not designed to integrate with EPC systems. To take full advantage of the new EPC-generated information, these legacy applications will need to be modified to integrate with new EPC systems – and to handle the large volume of data generated from reading tags and processing the information associated with them.

Integration Software and Services
Companies already have substantial investments in enterprise systems software along with specialized applications to manage supply chain, manufacturing, logistics and retail operations. For successful adoption, new EPC-driven applications will have to integrate with legacy applications using specialized integration software that aggregates large amounts of data from tag readers and integrates with different enterprise systems and unique service offerings.

To date, substantial progress has been made on tags and reader technologies. Given the early stage in EPC development, however, less progress has been made on specifying data management, applications and integration software required to build value in the CPG value chain.

5.2. Economic/Business Issues

Companies must also confront a number of economic and business issues related to EPC deployment. These include reducing tag and reader costs to levels suitable for widespread deployment, building detailed business cases to justify deployment, and building business models for cost-effective EPC systems deployment.

Tag and Reader Costs
To support the adoption of EPCs, RFID technology will need to become economically viable for the broad range of consumer goods. Current RFID technology costs orders of magnitude too much: Tags cost about forty cents, which is far above the barcode's penny-level cost and enough to significantly reduce the margins on most items. Readers cost between three hundred and five thousand dollars, meaning that large upfront investments for RFID applications – such as smart shelves in retail stores – that require multiple readers.

The Auto-ID Center's program specifically addresses cost issues, but companies will need to track progress over time. The Center conservatively estimates that new manufacturing techniques will lower the cost of passive tags to twenty cents in 2004 with additional scale driving the cost to five cents by 2006, though some vendors promise a shorter timeframe with rapid adoption at scale. The Center also expects that competition to provide open-standards-based readers that will drop reader prices to approximately seventy dollars in a similar timeframe. While particular Auto-ID applications will become economically viable as the cost of the technology decreases, it is possible that others will never offer economic justifications required to build and support them.

Business Case Development
With few exceptions, most companies we interviewed were in the early stages of developing business cases around cross value-chain applications of EPCs and RFIDs. Some were opportunistic, focusing on a very narrow application like reducing shrinkage of high-value items, while others were examining broader long-term benefits from inventory reductions that supply-chain visibility enables. We also found that companies have not found a consistent way to approach the development of business cases. Few companies have moved beyond developing business cases towards pilot-testing specific applications that would allow them to evaluate project feasibility and economic value.

A key challenge to business case development is finding applications of substantial value that cannot realize returns by simply modifying existing barcode-based legacy technologies. For successful EPC and RFID adoption, distinct and substantial new value must be generated that is unique, different from feasible options offered by barcodes. Given the widespread adoption of barcodes, the CPG value chain will have to support both technologies simultaneously.

Finding Consensus on Strategies and Economic Models for EPC Deployment
A third key business challenge is establishing consensus on strategies and economic models required for widespread cross-industry EPC deployment. In part, this includes the development of standards to support the widespread adoption of EPC and component technologies in data acquisition and management, applications and integration software. Standards enable interoperability required for value-chain applications to electronically tie together multiple companies' operations and allow for economies of scale in the production of vital components.

Groups like the Global Commerce Initiative (GCI), the Uniform Code Council (UCC) and the Auto-ID Center are currently playing crucial roles in developing industry consensus on standards. There does, however, also need to be a consensus on financial models for developing and supporting these new technologies in the marketplace.

Who, for example, should bear the costs of deploying EPCs, readers and related software when benefits may be greater for manufacturers versus retailers or vice-versa? Item-level EPCs provide retailers with tremendous benefits, but manufacturers, who expect only marginal benefits from item-level EPCs, must apply the original tag. On the other hand, even if retailers see relatively few benefits from case-level tags, manufacturers will want to track cases of their products into stores. And given the large number of retail outlets, it does not make sense for manufacturers to deploy proprietary readers that can scan only their own RFID tags. Instead, shared service solutions may be the most economical way to widely deploy key technology components.

6. GETTING THERE: DEPLOYMENT PATHWAYS

Alan Haberman, a central figure[18] in the widespread adoption of the UPC and barcodes, noted four key success factors for developing and deploying the previous generation of Auto-ID technologies:

- An initial focus on contemporary instead of future applications
- A conservative estimate of the benefits
- Getting buy-in of key manufacturers and retailers for critical mass
- Establishing a committee of influential executives to drive standard-setting and deployment

These key lessons remain critical to Auto-ID deployment. In addition, while the UPC and barcodes had to deliver value exceeding that of previous manual identification methods, the EPC and RFIDs must create compelling new value over and above the automatic identification that the UPC and barcodes enable. Much of this value resides in inter-organizational applications and item tracking as products traverse the value chain from manufacturers to customers.

Given the technical and business issues facing next-generation Auto-ID technologies, how can companies accelerate the profitable deployment of EPC and RFID initiatives across the value chain? It is clear that accelerating deployment will require consensus and commitment to technical standards and novel business models and practices by participating manufacturers, retailers and logistics services providers. We see companies adopting three basic approaches to deploying Auto-ID solutions. They will examine

[18] **Haberman**, 2001, pp. 153–54. It is important to note that Mr. Haberman has played a variety roles in advancing industry standards for automatic identification technologies. He has been a member of the Ad Hoc Committee for a Uniform Grocery Product Code and Chairman of its Symbol Selection Committee; member of the Board of Governors of the Uniform Code Council; Chairman of the Subcommittee on Automatic Identification and Data Capture Technologies of the Joint Technical Committee sponsored by the International Organization for Standards International Electrotechnical Commission; and Chairman of the Board of Overseers of the Auto-ID Center pro tem.

creating private systems, consortia systems or independent third party services depending on whether benefits are proprietary or common – and the precise benefit levels versus implementation costs per firm (see Table 1).

Table 1: Potential deployment approaches for Auto-ID systems

TYPE OF BENEFIT	BENEFITS/DEPLOYMENT COSTS (FOR INDIVIDUAL FIRMS)	
PROPRIETARY	(Unattractive)	Private Systems
COMMON	3rd Party Services	Consortia Services
	LOW	**HIGH**

6.1. Private Systems

Private systems will be established for proprietary Auto-ID benefits either by individual companies or in collaboration with key suppliers or buyers. We expect manufacturers will implement private applications of Auto-ID technologies for proprietary benefits such as process control or for building specialized applications in cooperation with key retailers. These specialized applications may include embedding RFID tags into products and displays to prevent the theft of high-value products or to verify product authenticity to discourage losses from counterfeits. For private systems to be successful, organizations that invest in system deployment must receive significant returns.

6.2. Consortia Models

Another way to deploy systems is to establish a consortium model that enables manufacturers and retailers to come together and fund the development and deployment of RFID tags, readers, data services and applications software. Consortia systems have advantages over private systems because they allow value-chain participants to share deployment costs. For Auto-ID systems, sharing the same reader, data management and applications infrastructure can dramatically reduce deployment costs for any one company. Not-for-profit consortia focused on deploying key cross-industry initiatives may be very effective in the early stages of deployment by creating standards and aggregating demand, offering third parties the incentive, for example, to develop specialized application software. Over time, consortia can become self-financing organizations by charging service fees or by spinning out profit initiatives after applications and services have proven themselves competitive marketplace offerings.

6.3. Third Party Services

Independent third parties can also provide various components and services to accelerate RFID and EPC deployments in the value chain. Third-party logistics, warehouse and pallet providers, for example, who deploy RFIDs on their assets such as trucks, pallets and reusable containers, can use this capability to provide more detailed tracking of pallets and cases for manufacturers as shipments traverse the value chain. Others, such as software vendors, may provide data management and other application services. Third party services are most appropriate when the type of benefit sought by the buyer isn't proprietary and the ratio of benefits from the system – relative to the cost for any user to individually develop the system – is low. If the market opportunity is significant, a specialized third party may enter to aggregate demand across industries and provide for-profit solutions to value-chain participants. We expect third parties to provide key data management and application services.

We anticipate all three Auto-ID engagement models will operate for different applications and services in support of EPC and RFID deployment in the CPG value chain. A major concern among different interviewees was that EPC not be viewed simply as a solution for large manufacturers and retailers. Nearly all respondents emphasized the need for broad industry solutions. The formation of the Global Commerce Initiative (GCI) by a number of major manufacturers and retailers provides a critical vehicle for developing consensus on technical and process standards in the industry. In concert with broad standards setting by the Uniform Code Council and European Article Number Initiative, we expect the GCI to be especially important for building shared industry solutions for deploying EPCs.

7. HARNESSING POTENTIAL: BEGIN AT THE BEGINNING

Today the EPC is still in its infancy, but basic RFID technologies have already been proven commercially. As technology advances to make the EPC and low-cost RFID systems a reality, companies in the value chain should begin readying themselves for this transformation. There are a few key activities companies can undertake to prepare for coming changes to value creation in their industries.

7.1. Value Targeting

Value targeting allows companies to identify the most promising benefit categories from EPC or RFID technology. It allows for the development of more detailed cost-benefit analyses and business cases for specific applications. In retail, for example, these may include applications to reduce shrinkage, monitor counterfeiting and accurately track stock to reduce stock levels and improve the effectiveness of promotions and merchandising strategies. Effective value targeting requires detailed data driven analyses to generate clear hypotheses about how particular companies can realize value from specific applications.

7.2. Aligning Opportunities and Deployment Models

For each of the different opportunities identified in the value-targeting exercise, companies can decide if the benefits are proprietary to the firm, shared with select partners or whether the application will become an industry standard that offers all participants similar benefits. Next, they can analyze the relative costs and benefits of deployment through private systems, consortia or third-party services models. Based on this analysis, they can select the model that best meets their organization's benefit requirements and deployment criteria. At first, we expect most applications will be private solutions. Over time, however, we expect consortia and third party solutions to become more viable.

7.3. Building Pilots to Test and Refine Deployment Models

A third 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. 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. A number of companies are already undertaking pilot implementations in advance of low-cost RFID and EPC development to explore how the technology can be used to improve processes and to identify requirements for integrating with legacy applications and processes.

Pilots are vital for learning how to effectively realize value from Auto-IDs. Conducting pilots early can give companies insights into issues such as categories most frequently out of stock or ways 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.

7.4. Scaling to Grow the Benefits

If pilot tests show great promise, the next step is to scale the deployment of the application across the company and, if appropriate, with key suppliers or buyers. We expect most companies to roll-out industry wide applications beginning two years from now as technical and business issues surrounding the widespread deployment of new Auto-ID technology are resolved.

8. CONCLUSIONS

EPCs and RFIDs, the next-generation Auto-ID technologies, are advancing rapidly towards becoming a low-cost auto identification technology comparable in price to barcodes but offering greater functionality.

These Auto-ID tools promise to dramatically transform industry value chains by providing manufacturers, retailers and logistics providers and number of new benefits:

- More responsive supply chains
- Increased revenue through fewer out-of-stock situations
- Lower inventory carrying and management costs
- Improved asset utilization

As benefits accrue from collaborative cross-company applications, companies will need to work closely with industry organizations such as the Global Commerce Initiative to arrive at consensus on common standards and processes that will drive benefits. In parallel, managers should begin value targeting, business case development and pilot deployment to learn the most effective ways of leveraging emerging Auto-ID technologies for the benefit of their companies.

9. APPENDIX: AUTO-ID ACROSS THE VALUE CHAIN

Our research has identified a breakdown of potential Auto-ID applications and associated benefits. These applications vary in terms of the level and scope of benefits they provide for value chain participants, the physical infrastructure requirements they possess – including the number and placement of readers and attachment of tags to pallets, cases or items – and the level of inter-organizational cooperation that value-chain participants must aspire to.

Table 2 summarizes key Auto-ID opportunities in the CPG value chain and supports these with descriptions of application areas following the table. While most companies are in early stages of building detailed business cases, this table of major process areas, potential applications and categories of benefits provides a basis for mapping the potential benefits of Auto-IDs to infrastructure and cooperation requirements at each point along the value chain.

Table 2: Auto-ID Value Chain Opportunities

KEY

1. Priorities
M – Manufacturers
L – Logistics Providers
R – Retailers

2. Reader Requirement
F – Few (e.g., at doors)
S – Some (e.g., at workstations)
M –Many (e.g., on shelves)

3. Tags
A) Level
P – Pallet
C – Case
I – Item

B) Marginal Benefit
L – Low
M – Medium
H – High

PRIORITIES M	L	R	FUNCTION/ ACTIVITY	POTENTIAL BENEFITS	READER REQUIREMENTS	TAGS P	C	I
			CROSS-SUPPLY CHAIN					
M		R	**DEMAND PLANNING**	– Reduced or eliminated out-of-stocks – Decreased order lead time – Automated planning tied to consumer purchases – Increased inventory turns – Decreased safety stock	F, S, M		H	M
			ITEM/BATCH/ LOT TRACKING	– Reduced sale of counterfeit products – Increased compliance w/distribution contracts – Increased product quality	F, S, M			H
M		R	**SECURITY**	– Decreased unauthorized access to facilities – Decreased chances for product tampering				
			MANUFACTURING					
			PROCUREMENT & MATERIALS STORAGE	– Reduced order lead time – Increased raw material availability – Higher capacity utilization	S, M		M	M
			PRODUCTION	– Higher capacity utilization – Reduced order cycle time – Increased quality	S		L	H
			WAREHOUSING					
			RECEIVING	– Decreased unloading times – Increased accuracy of accepted shipments	F	L	H	L
			ORDER SELECTION	– Increased accuracy of orders – Increased order fill rate	S, M	L	H	L
M			**EXCEPTION PRODUCT LOCATION**	– Fewer misplaced items – Decreased time to locate specific items	M	L	H	L
			LOSS PREVENTION	– Reduced shrink	F, S, M		M	L

Continuation of Table 2:
Auto-ID Value Chain Opportunities

KEY

1. Priorities
M – Manufacturers
L – Logistics Providers
R – Retailers

2. Reader Requirement
F – Few (e.g., at doors)
S – Some (e.g., at workstations)
M –Many (e.g., on shelves)

3. Tags
A) Level
P – Pallet
C – Case
I – Item

B) Marginal Benefit
L – Low
M – Medium
H – High

PRIORITIES M	L	R	FUNCTION ACTIVITY	POTENTIAL BENEFITS	READER REQUIREMENTS	TAGS P	C	I
			TRANSPORTATION					
	L		**ASSET MANAGEMENT**	– Increased productivity of assets – Reduced loss of assets – Pricing based on actual use of assets	**F, S**	**H**	**H**	
			YARD MANAGEMENT	– Increased productivity of assets – Increased visibility of drop shipments	**F, S**	**M**	**M**	
			CONTRACT COMPLIANCE	– Decreased exceptions management – Increased customer satisfaction	**F, S**	**M**	**M**	
			ROUTING	– Dynamic routing	**S**	**M**	**M**	
			STORE OPERATIONS					
			RECEIVING	– Decreased unloading times Increased accuracy of accepted shipments	**F**	**L**	**H**	
		R	**STORE PLANNING & PLANOGRAMMING**	– Increased margin	**M**		**L**	**H**
		R	**EXCEPTION MERCHANDISE**	– Increased on shelf	**F, M**		**M**	**H**
		R	**LOSS PREVENTION**	– Reduced theft	**F, M**			**H**
		R	**CHECKOUT**	– Increased accuracy of checkout – Increased productivity of checkers – Reduction in number of checkers (w/self checkout)	**S**			**H**
			RETURNS & REVERSE LOGISTICS	– Increased accuracy of returns acceptance – Increased accuracy of refund amounts – More efficient disposal	**F, S**			**H**
			POST-SALES SERVICE	– Increased warranty compliance – Faster warranty and repairs processing	**F**			**H**

9.1. Cross Supply-Chain Activities

Demand planning is one of a number of supply-chain activities that promises to provide the greatest number of Auto-ID benefits across the value chain. Case-level tags provide the most significant benefit from manufacturers all the way to the back room of retail stores. Item-level tags will obtain demand signals from retailers' floors.

Demand Planning and Replenishment
This area stands to benefit tremendously both in supply and demand. On the supply side, having a precise knowledge of what is truly on hand will provide a much more accurate base for replenishing products. Similarly, on the demand side, virtually all product movement data – such as sales, theft or damage – can be captured, making the projection of demand more accurate. As a result, retailers should experience better in-stock positions and sales, which should provide manufacturers an additional sales boost.

Item, Batch and Lot Tracking
Tracking items through the value chain provides a record of the items' origins. Counterfeit items can be easily identified by the fact that their EPCs are either missing, illegitimate or duplicate EPCs on known authentic products. Products moving through specific distributors can be tracked and limited to their contracted regions while problems with individual items can be traced to whichever point in the supply chain that may have caused them. Made-to-order items can be tracked to ensure that they are ultimately delivered to the correct customer.

Security
Access control systems can make product tampering less likely. Information on product quality and authenticity can provide the assurance that products haven't been tampered with.

9.2. Manufacturing

Manufacturing offers numerous areas that would benefit from advanced Auto-ID technologies.

Procurement
Manufacturers can gain significant efficiencies by improving the linkage with raw materials suppliers. Case-level tagging of suppliers' goods will enable manufacturers to ensure that sourced raw materials are available from suppliers just in time, automatically triggering delivery, and easily locating them at the plant so they can be efficiently stored and rapidly retrieved.

Production
Greater visibility through the production process and greater insight to end-customer demand represent considerable production opportunities. Tracking products as they move through manufacturing process can help identify and resolve bottlenecks, increasing throughput and capacity utilization, while identifying the sources of defects to increase product quality. As work-in-progress inventory become finished goods, Auto-ID applications can automatically trigger downstream transportation. Linking to real-time, end-customer needs can enable planners and schedulers to respond immediately to demand spikes, raising service levels and reducing the need for buffer stocks.

9.3. Warehousing

A typical distribution center of 500,000 square feet might process several million units per week and employ 500 people across two shifts, with an annual employee turnover rate of almost 100%. Under these conditions, even the best run operations are challenged to get it all right. A technology that could help them prevent mistakes would deliver strong return on investment.

Receiving
Pallets and cases can be received using Auto-ID tags, increasing the productivity of dock workers, making receiving more accurate, and allowing invoices to be automatically matched.

Order Selection
Item-level Auto-ID tagging will drive more accurate processing of orders by validating orders and items, increasing distribution centers' order-fill rates and leading to better in-stock positions in stores. In addition, when facilities become completely wired, distribution centers will be able to locate misplaced items and improve order-fill rates even more.

Exception Product Location
For situations where particular items must be located – such as specific batches or lot numbers or items reaching expiration dates – Auto-ID tags provided by the manufacturer can immediately locate these substandard and potentially harmful products, increasing product quality and consumer safety.

Loss Prevention
For items that are particularly susceptible to theft or damage, distribution centers equipped with radio-frequency readers could alert management to product movement that isn't required for fulfillment[19].

[19] Texas Instruments case study. "Protecting Valuable Products During Distribution." See http://www.ti.com/tiris/docs/solutions/supply/logsup_bond.shtml

9.4. Transportation

Because transportation is a capital-intensive business, transportation providers are looking to improve how they use their assets. Transportation providers will be able to provide customers – and their own operations teams – with much more accurate information on the status of their goods.

Asset Management
Auto-ID-enabled receiving operations will reduce how long it takes to load and unload trailers, resulting in better asset productivity.

Yard Management
Auto-ID tags attached to trucks and trailers will increase the reliability of the yard management. Shipment-level Auto-ID tags will increase the visibility of products that are sitting in yards but have not been officially received by ERP systems[20].

[20] **Songini, Marc** ibid. See http://www.computerworld.com/itresources/rcstory/0,4167,STO69884_KEY258,00.html

Contract Compliance
One of the critical success factors in working with outsourced transportation is managing service levels. Auto-ID will provide both the outsourcer and the retailer with accurate status on how a given shipment is being processed. This data can be cross-referenced with vendor invoices and carrier manifests along with appropriate service-level agreements.

Routing
Real-time location information for specific shipping units can enable dynamic routing of products so that they arrive where they'll best serve customer needs.

9.5. Retail Stores

When item-level tagging occurs and readers are deployed on shelves, retailers will experience important and significant benefits, including improved data integrity that will help to reduce labor costs and out-of-stock situations.

Receiving
Item-level tagging provided by the vendor can be used to automate the receiving process, increase inventory accuracy and improve store labor productivity. For receipts direct from the vendor, the data can be used for invoice matching and for vendor compliance. For receipts from a company-operated distribution center, the data can be used to track DC shipping accuracy.

Store Planning & Plannogramming
Auto-ID based location information can reveal which areas of the store (end-caps or traditional aisle placements, for example) drive the highest sales for a particular product. Armed with this information, store planners can better determine where products need to be placed to maximize sales. New planograms, floor sets or straightening the floor all require that products be located so they can be placed properly. Auto-IDs can support locating misplaced product, enhancing labor productivity and improving visual merchandising.

Exception Merchandise
Auto-ID can allow particular occurrences of merchandise to be quickly and accurately identified/located so that it can be properly managed and dispositioned. Examples include recalled lots, expired product, open stock and layaway.

Loss Prevention
Retail security systems using Auto-IDs will be able to detect when product is removed from the store that has not been processed by a POS system, alerting store security for potential intervention. Retail security systems will no longer be limited to knowing that a single product has left the building, but will now know exactly which product walked out the door. Capturing this non-traditional product movement will provide additional data for use in decision support systems.

Checkout
- ITEM ACCURACY: Increased checkout accuracy can be achieved with RFID-enabled registers, since it reduces reliance on multiplier keys.
- CHECKOUT PRODUCTIVITY: Since RFID systems do not rely on line of sight, checkers will be able to scan items at a higher rate, decreasing the amount of labor required to support checkouts.
- SELF-CHECK: Auto-IDs will make existing self-serve kiosks more productive and will enable new types of self-check kiosks to reduce checkout labor.

Returns & Reverse Logistics
Using item-level tagging, retailers would know exactly when an item was sold (or if, in fact, it was sold at all) and for what price. This will reduce shrinkage by allowing retailers to better enforce return policies for discount purchases, returns beyond time limits, items purchased at other retailers and stolen items. Auto-ID information on returned items can also provide information for quality control and safe disposal.

Post-Sales Service
Products that have been brought into the store for service/repair can be tracked with Auto-IDs, providing information about sales dates and locations and manufacturing dates and locations. This information can enable improved compliance with warranties and recalls, faster processing of service requests, and provide data that manufacturers can use to improve product quality.

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