SAP White Paper

SAP® AUTO-ID INFRASTRUCTURE

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EXECUTIVE SUMMARY

The SAP® Auto-ID infrastructure (AII) is a networked software infrastructure that manages real-time information from electronically tagged items, environmental sensors, global positioning systems, and wireless data for use by any enterprise application. The SAP Auto-ID infrastructure combines the virtual world with the real world of products and people. By providing accurate, real-world, real-time data and information, AII allows companies to close the loop between acquiring data, converting it to meaningful information, and automating all associated transactions and processes – creating networks that are smarter, more responsive, and more adaptive.

INTRODUCTION

SAP Corporate Research, in collaboration with several SAP product and industry teams, is currently developing an automatic-identification (Auto-ID) infrastructure, called AII, as part of SAP Corporate Research's Smart Items research program.

SAP is also collaborating with various external academic organizations and consortia. These include the Auto-ID Center, Harvard University John F. Kennedy School of Government Belfer Center for Science and International Affairs, Rutgers University, the Stanford Global Supply Chain Management Forum, and the M-Lab (a joint initiative of ETH Zurich and HSG University of St. Gallen in cooperation with the Auto-ID Center). SAP is one of the founding sponsors of both the M-Lab and the Auto-ID Center. The M-Lab's founding sponsors include SAP, Volkswagen, Novartis AG, Swisscom, UBS AG, and Hartmann. The Auto-ID Center, founded in 1999, today has more than 70 sponsors in 3 continents. Members include Procter & Gamble Co., Philip Morris USA, Wal-Mart Stores Inc., Metro AG, Target Corp., Kraft Foods Inc., Unilever, Johnson & Johnson, The Coca-Cola Co., U.S. Department of Defense, United States Postal Service, and United Parcel Service of America Inc.; technology and service vendors including Intel Corp., IBM Corp., Sun Microsystems Inc., and Accenture; and radio frequency identification (RFID) hardware vendors such as Philips, Alien Technology Corp., Matrics Inc., Intermec Technologies Corp., and ThingMagic LLC.

More than 550 billion items pass through the Auto-ID Center sponsors' supply chains every year. The Auto-ID Center estimates the annual benefits of an integrated global Auto-ID infrastructure to be more than $204 billion, and based on industry reports, such an infrastructure could slash total supply chain costs by 3% to 5%.

WHAT IS AII?

"Today's supply chain management tools share a fundamental flaw of assuming rather than knowing where things are. RFID technology in combination with adaptive agents will help us to bridge the gap between the physical world and the digital world to create real-time, real-world-aware supply networks that are smarter, more responsive, and more adaptive. We believe that the use of dynamic information for better real-time decision making across enterprise boundaries will become a significant source of competitive advantage by allowing companies to constantly adapt based on real-world conditions." – Claus Heinrich, member of the executive board at SAP.

AII is a networked software infrastructure that will acquire, filter, model, aggregate, store, associate, and communicate massively high volumes of real-time smart-item information from electronically tagged items, environmental sensors, global positioning systems (GPS), and wireless data for any enterprise application. AII will also provide bidirectional communications and control of Auto-ID readers and tags, which will allow functions such as remote updating of a product's price or of its recall or routing instructions. Auto-ID-enabled tags allow objects – including consumer products, mobile devices, trucks, pallets, shelves, and shopping baskets – to be associated with dynamic information about their characteristics. Each Auto-ID-enabled tag, which might be a certain type of bar code, RFID tag, or Bluetooth-enabled or wireless-LAN-enabled tag, provides unique item-level information about its associated asset. RFID and other wireless-tag technologies also allow the unique identification of every physical object to be communicated wirelessly without human effort or line-of-sight reading. Information regarding each object, including manufacturing data, storage and task instructions, price, shelf-life information, and even postpurchase warranty and service information can be added or updated by writing or rewriting data on the tag and in the Auto-ID infrastructure. This process can take place throughout the supply chain – from the object's manufacture to sale, service, and returns. By connecting smart items on retail shelves to the supply network, retailers can automate in-store logistics, dynamically update pricing and promotion information on each smart item, and activate the larger supply network by triggering replenishment requests.

The Auto-ID infrastructure filters, aggregates, associates, integrates, and synchronizes information from the virtual world with the real world of products and people, enabling companies to sense and respond to Auto-ID information across the extended enterprise in real time.

KEY BUSINESS DRIVERS

The key needs and business drivers for the Auto-ID infrastructure are summarized below.

- *Improve inventory management and asset visibility across the value chain.* In a recent IBM Global Services survey at the Electronic Product Code (EPC) Forum, the biggest Auto-ID application priorities for both manufacturers and retailers were improved inventory management and reduction of stock-out conditions (IBM Global Services, 2003). Other top priorities for manufacturers included improved warehouse management and transportation and logistics management. Retailers ranked theft reduction and warehouse management as their other top priorities.
- *Improve the quality of cross-enterprise data.* Poor data quality results in wasted time, money, and resources, as well as a lack of trust between business partners, which inhibits collaboration. In a recent survey by IBM Global Services, only 15% of the respondents were very confident in the quality of the data they receive from partners, and only 37% were very confident in their own data. Due to these problems, a third of the respondents were forced to delay or cancel new systems, reducing their businesses' ability to fully automate their business processes and to realize the full value of their IT investments. IBM Business Consulting Services estimated the financial impact of poor data quality could easily exceed $100 million per year for a large company.
- *Manage massive volumes of new item-level data.* Item-level tagging and complete adaptive supply networks would be impossible to manage without a reliable and secure Auto-ID infrastructure. Tracking an individual selling unit from manufacturing through distribution and sale, for example, could result in more than 3,000 events per second hitting enterprise systems.
- *Improve collaboration and integration across multiple business units and trading partners.* Perhaps the biggest benefit of the standards emerging from the Auto-ID Center are that they will allow companies to share any data they want across their value chain using ubiquitous Auto-ID data standards and communications protocols. Improved data and communications standards and interoperability will in turn reduce investment risk for buying new Auto-ID solutions, improve the reliability of the data, reduce data management and integration costs, and reduce the communications barriers between companies. Using standards-based Auto-ID solutions will thus enable companies to acquire, distribute, and respond to data on any device, anywhere, anytime.
- *Improve inventory management and new-product introductions.* Every day that new products are not on the shelf due to stock-out conditions can translate into millions of dollars of lost profits. Consumer electronics companies, for example, earn more than 80% of their profits, on average, within the first three months of a product's life cycle. In addition, markdowns on old and unsalable inventory can erode more than 30% of a company's potential product revenue. Reverse logistics (returns) reduce the profits for the computer and consumer electronics industry by as much as 25% – and up to 40% for CD-ROM and DVD drives (IBM Global Services).
- *Improve security and reduce theft.* Theft costs manufacturers between 0.22% and 0.73% of revenues, depending on the product category (IBM Global Services, 2002). Theft alone accounts for about 1.8% of total annual turnover. Given that every dollar of shrinkage reduction could translate into two to three dollars of added profit, shrinkage reduction could become the largest source of a retailer's profit. Lost revenues due to employee-related theft are, on average, two times greater than the loss due to consumer theft. Providing 100% accurate information on each asset throughout the value chain – from manufacturing to shipping, receiving, stocking, and sale – will help substantially to improve retailers' profitability by reducing demurrage and improving product availability. IBM estimates that an Auto-ID implementation at the case level and item level could reduce theft losses by 47% (IBM Global Services, 2002).

INTRODUCTION TO THE AUTO-ID INFRASTRUCTURE

AII provides an architecture for a universal Auto-ID networked infrastructure that can acquire, filter, model, aggregate, store, associate, and publish massively high volumes of real-time Auto-ID information from tagged items for use by any enterprise application anywhere, anytime. AII provides a rich basis not only for new tools and applications that will increase visibility within the enterprise, but also for existing enterprise applications that provide capabilities for detailed, real-time, item-level analytics, control, execution, and decision making.

KEY AII REQUIREMENTS AND CAPABILITIES

Widespread Auto-ID deployments will require a new breed of data management software and network services. As RFID and bar-code readers interrogate billions of tags at multiple points in the value chain, they generate vast amounts of item-level data that must be processed and communicated across the value chain. AII must be able to do the following:

- *Capture, filter, and publish data from multiple readers for individual items and shipping units.* Maintain the information from tag reader systems that identifies individual items. Provide context information, such as product location, shelf life, current price, and inventory level.
- *Aggregate, integrate, associate, and store information about items, pallets, cases, and shipments, including historical information.* Receive and maintain information specifying the location and physical relationships between and among items, including changes in those relationships. For example, keep track of the information that a particular bottle is in a box; the box is on a pallet; the pallet is put into a container; and the container is put onto a ship.
- *Integrate seamlessly with current and future enterprise applications.* Receive and maintain smart-item information in an extensible form, so that new kinds of information supplied by enterprise applications – such as warranty or pricing information for items – can be added and maintained without any reprogramming of the core infrastructure.
- *Provide bidirectional communications and control.* Publish information to applications and devices, as well as make the information available by query to any application or device. Control bidirectional communications, ensuring that each user, application, or device receives accurate and secured information. Communicate with and directly control Auto-ID hardware-sending, for example, updated pricing, shelf-life, and storage information to the reader, which could, depending on the type of Auto-ID tag, update the tag with the new information.
- *Make data meaningful by processing it into useful information and reports.* Provide Auto-ID information across enterprise boundaries in a universally accessible form – such as eXtensible Markup Language (XML) documents – so that the information can seamlessly integrate into any enterprise application environment.
- *Support multiple systems.* Make it easy for companies to capture and communicate their Auto-ID data at every data access point by allowing rapid deployment of AII across the entire value chain, with the ability to integrate and interoperate with existing enterprise applications and IT landscapes.

WHERE DOES AII FIT AMONG ENTERPRISE APPLICATIONS?

AII is not a new enterprise application or database. It is a real-time information layer that integrates with current and future heterogeneous enterprise IT environments. AII does not make business decisions or automate operational processes or transactions. It is not a business intelligence application. AII captures transitory event data from smart items across the value chain and integrates the data into a structured model that represents the current disposition of each smart item.

AII and SAP NetWeaver™

Because AII is designed to be deployed in extremely heterogeneous environments, it can be used by multiple trading partners with endless varieties of IT landscapes across the value chain. AII is capable of synchronizing multiple partners' data by using a single application across the value chain. This is accomplished by integrating AII as an information service in SAP NetWeaver™ as part of the information integration layer. Trading partners can then access any application and back-end system across the trading network as a Web service via the business-object application framework layer. This SAP NetWeaver layer makes it possible to write a single application and deploy it in various environments, dynamically generating standard

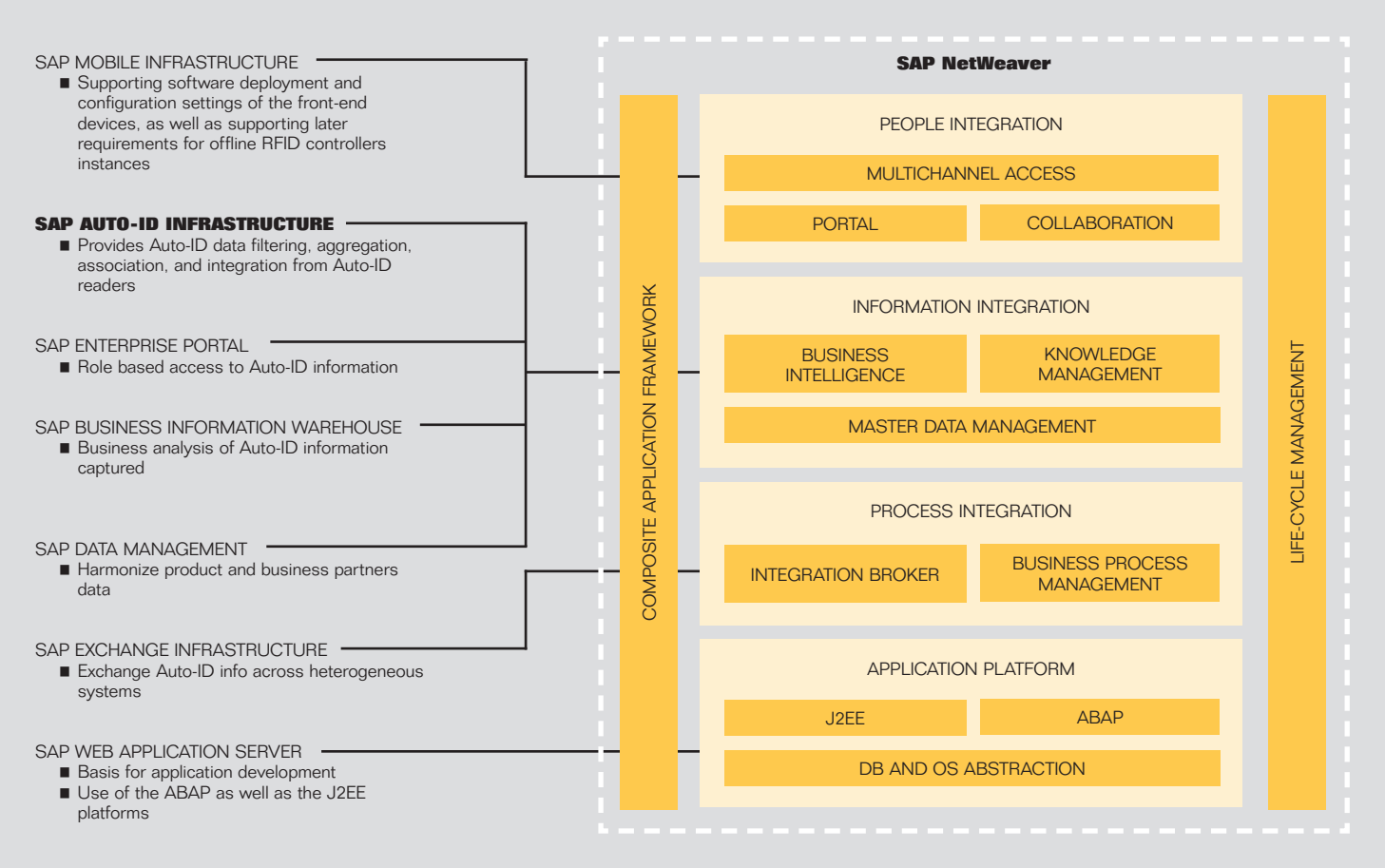

Figure 1: SAP NetWeaver

information objects with the needed application programming interfaces (APIs) for any trading partner's IT landscape. Since the application need only be written once instead of for each landscape, customers can rapidly deploy and scale AII and associated applications across the value chain, while realizing the full value of their existing IT investments.

WHY DO COMPANIES NEED AII?

Today's enterprise systems are simply not designed to receive and react to the huge volumes of real-time, item-level information that can be rapidly transmitted from RFID or bar-code readers, GPS locators, or other Auto-ID information sources. Nor do most of today's enterprise systems track the serial numbers of items. Directly integrating Auto-ID data into enterprise applications can work for small, closed-loop deployments in a single store or site. However, the enterprise application becomes substantially overloaded as soon as the Auto-ID data needs to be synchronized or leveraged across multiple stores, distribution centers, warehouses, or manufacturing sites in a network.

AII is an open, generic, distributed, and independent system, so it can handle a huge number of Auto-ID events without burdening core enterprise software systems. The rate of information inflow may be extremely high. For example, gate readers at a loading dock can deliver a peak read rate of more than 20 reads per second, resulting in a peak rate of 200 reads per second for a distribution center with 10 loading docks, not taking into account other readers in the facility. A detailed study

of one company's requirements showed that distributing and tracking 5 million items per day required an average rate of 378 reads per second at each location during business hours, with readers spread across more than 1,000 distribution points.

Large volumes of information from Auto-ID readers, moving trucks, assets, and other data sources are used to update the AII association model, which represents the current disposition, hierarchy, and context of all tracked items, such as individual items, cases, pallets, containers, and shipments. Existing enterprise systems can access or automatically receive and react to all the information in the association model as needed and need not deal with complex real-time events.

Individual enterprise applications generally need only a small subset of the total information captured. The specific information needed varies widely by application and by location in the value chain. Rather than retrofitting each of today's enterprise systems to capture and digest the enormous quantity of real-time data coming from electronic sensors, it makes sense to develop a special-purpose information layer that shields enterprise applications from the massive quantities of information from RFID readers, which can read Auto-ID tag data every 5 milliseconds. It also makes sense to shield enterprise applications from the complexities of interpreting and filtering those signals, and instead to make comprehensive, organized, and relevant information available to those applications.

THE BENEFITS OF AII

AII provides the following operational and financial benefits.

Operational

- An architecture that interprets, integrates, manages, filters, and associates data from any source of real-time Auto-ID data – and makes that information available to any application or device, anytime and anywhere across the value chain
- The ability to manage and filter millions of bits of data – and thousands of events per second – in real time in distributed enterprise environments
- Real-time tracking, association, storing, and modeling of Auto-ID data across multiple network locations that can be published to and updated by any integrated trading partner
- Real-time, reliable, networked, and synchronized data that enables decentralized decision making and true adaptive supply chain planning, process management, and execution
- Support for multiple applications to use, synchronize, and update Auto-ID data across multiple processes – from manufacturing to distribution, sales, customer service, and end-of-life returns, maintenance, and support
- The ability to minimize application failures or overloads by publishing only relevant information
- The information needed to employ new business models, such as building to actual customer demand and usage rather than building to order
- Operational continuity by maintaining local Auto-ID information for use in the event of network or communications outages

Financial

- Substantially reduced Auto-ID integration costs and time as a result of having a single point of integration for any application, end user, trading partner, or mobile device
- Real-world knowledge that replaces assumptions – enabling managers to improve forecast accuracy and inventory availability, to coordinate production better, and to reduce lead times and fulfillment times for orders
- Accelerated time to volume for new products as a result of every product being completely visible throughout the entire value chain, which makes it easier to ensure that new products are always available
- Support for mass product customization and true building to demand by integrating customer requirements and usage information, parts availability, and production schedules in real time – thus truly integrating customer relationship management and supply chain management applications
- Higher total return on IT investment as a result of improved quality, speed, reliability, and availability of data within the enterprise and across the entire value chain

INDUSTRY OVERVIEW

From bar codes to smart cards, automatic-identification technologies are now widely used in nearly every industry around the world. Their applications range from access and security management to item tracking, inventory management, and simplified checkout at retail stores. Auto-ID originated with the development of bar-code readers in 1952, bar codes in 1966, and the Universal Product Code (UPC) in 1973. While bar codes are now virtually ubiquitous, it took more than 11 years for them to reach broad retail acceptance. The adoption rate accelerated in 1984 when Wal-Mart, Kmart Corp., and Bullocks switched from optical character recognition to bar codes. The number of participating suppliers increased from 15,000 in 1984 to 75,000 within 3 years. Today, more than 5 billion bar codes are scanned every day in 140 countries.

The ubiquity of UPCs and bar codes has made a dramatic impact on the consumer packaged goods (CPG) industry. By leveraging bar-code and UPC technologies, the grocery industry, for example, realized hard and soft savings of 2.76% and 2.89% of total revenue, respectively (Accenture, 2002). By 1997, the industry estimates that hard and soft cost reductions added up to approximately $17 billion in total annual savings, with achievements in every area of the end-to-end value chain – from production to the store shelf.

THE ELECTRONIC PRODUCT CODE

One of the most powerful concepts introduced by the Auto-ID Center is the Electronic Product Code (EPC). The EPC serves as a reference to information on the computer network. The EPC, which is attached to every physical object of interest, is analogous to the IP address that uniquely identifies computing nodes on the Internet.

The EPC, a 96-bit number, is embedded in a radio frequency identification memory chip (smart tag) on an individual product. Each smart tag is scanned by a wireless radio frequency reader, which transmits the product's embedded identity code to AII, where information on the product is kept. The EPC is similar to the Universal Product Code/European Article Number (UPC/EAN), but while the UPC/EAN identifies a class of objects, the EPC uniquely identifies an individual object.

PRODUCT MARKUP LANGUAGE AND OBJECT NAMING SERVICE

The EPC works together with Product Markup Language (PML) and Object Naming Service (ONS). PML is a new standard language for describing physical objects to the Internet, in the same way that HyperText Markup Language (HTML) is the common language on which most Web sites are based. ONS tells computer systems where to find information about any object that carries an EPC code in a smart tag. ONS is based in part on the Internet's existing domain name system (DNS), which routes information to appropriate Web sites. ONS will likely be many times larger than DNS, serving as a real-time message router that locates data for every object among trillions of objects carrying an EPC code.

RFID TECHNOLOGY

RFID systems can obtain and communicate any information that the end user enables on the RFID tag. An Auto-ID tag, typically a radio frequency tag, serves as an electronic bar code that can be read remotely by wireless readers, does not require line-of-sight reading, and can contain unique item-level information. Unlike UPC bar codes that are limited to 12 to 15 digits and are printed once on a product label, RFID tags can hold up to 1 megabyte of information and can be rewritten as many as 100,000 times. This means that beyond just identifying a product SKU, an RFID tag can identify the individual unit of the product, as well as carry and update data added to it throughout the supply chain process. This information can include manufacturer data; warehouse and shipment location and transmit times; store-shelf arrival times; the product category, unique description, and SKU number; temperature; routing, storage, and configuration instructions; pricing; security, and access control information; warranty and maintenance information; and end-user or owner IDs.

RFID tags typically consist of an electronic microchip that stores data and an antenna used to communicate via radio frequency waves. Tags are transponders that may be either active or passive. Active tags contain a power supply such as a battery, whereas passive tags obtain all their power from the interrogation signal of the transceiver. The tag readers typically consist

of a radio frequency module, a control unit, and an antenna to interrogate electronic tags via radio frequency waves to obtain the information stored on them. This information can be static ID numbers, user-written data, or sensory data. The transceivers communicate their received data to the data-processing subsystem via an interface.

Key Differences Between Bar Codes and RFID Tags

Bar Code	RFID Tag
▪ A UPC bar code identifies the SKU as belonging to a group of objects or products. ▪ The bar code is printed once and cannot be modified. ▪ A bar code contains only 12 to 15 characters of data. ▪ Two-dimensional bar codes can contain additional data. ▪ Reading the bar code requires human intervention and line of sight using handheld or fixed-point lasers or light-emitting diodes. ▪ The bar code cannot work if the label is damaged.	▪ Hundreds of tags can be read simultaneously in a few seconds. ▪ Tag can be rewritten thousands of times. ▪ An RFID tag can store hundreds of bits of data. ▪ Receivers can scan the radio signal from the RFID tag from 1 mm to 300 feet. ▪ Readers can be embedded in any device within range of the tag; no line of sight is required. ▪ Tags can withstand harsh industrial environments, water, and extreme heat.

INDUSTRY ADOPTION

Companies' adoption of standardized Auto-ID technologies such as RFID readers and tags will vary depending on the complexities of their supply chains, their integration capabilities and data standards, and their sensitivities to costs and time. In general, early adopters will be companies that can improve their supply chain efficiency and inventory management by implementing Auto-ID at the pallet level and the case level within the four walls of their organization. Mainstream adoption at the item level will be driven by reduction in tag costs, adoption of ubiquitous technology standards, and corporate acceptance of collaboration and information sharing.

The benefits of using the Auto-ID system increase significantly as companies transition from tagging pallets to tagging cases, then proceed to tag items and increase the degree of collaboration and sharing with their trading partners. Figure 2 portrays the increase in benefits realized by moving to a more granular level of tagging.

Tag costs constitute the majority of the costs involved in an Auto-ID system implementation. A company's product price points and characteristics, current business performance, current infrastructure, and physical attributes of the products are all factors that affect the time and scope of adoption. For some companies, supply chain inefficiencies may lead to early, item-level adoption in a pilot program for certain high-margin and high-risk products. Other companies may wait for the establishment of a technical standard and lower technology costs before choosing to adopt the Auto-ID system at the item level.

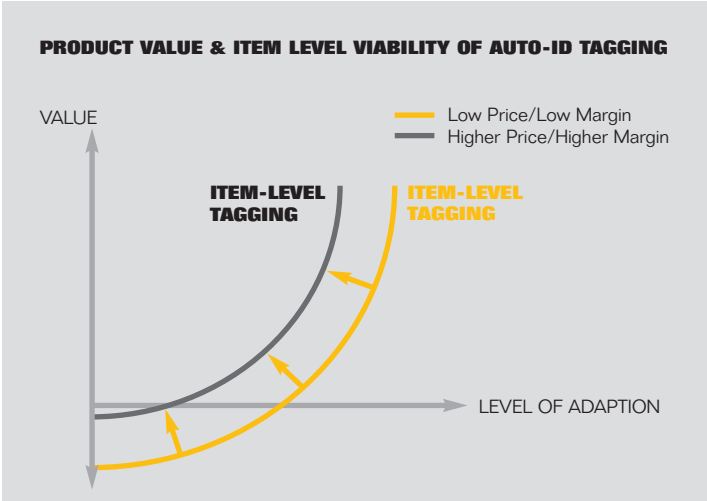

Figure 2: The Benefits of Auto-ID Increase When Tagging Is at the Item Level (Source: IBM Global Services, 2002)

Electronic Product Code Forum Survey Results

The EPC Forum Survey obtained responses from more than 60 Auto-ID Center sponsors and other companies. Conducted by IBM Global Services and Accenture, the survey was completed by a wide range of respondents with expertise in finance, supply chain, marketing, and technology. Respondents were from locations including Europe, South America, and the United States. A large number of the respondents were employed by manufacturing companies, with fewer participants employed by retailers and other supply chain participants.

PLANS TO ADOPT ASSET TAGGING AND AUTO-ID SYSTEMS

More than 80% of the respondents expected to be tagging at least some of their products in the next 24 months. More than 35% predicted they would be tagging at least 10% of their products, and 12% indicated they will be tagging at least half of their products. This indicates that usage will be broad and volumes will be significant (Accenture, 2003).

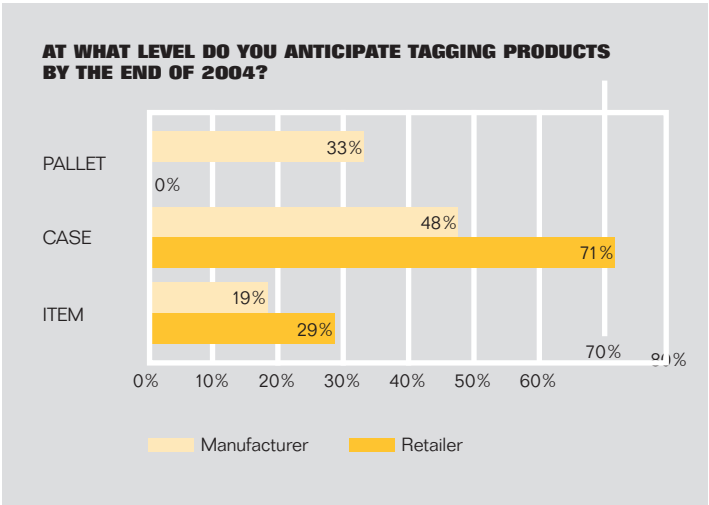

Figure 3: Retail Tagging Plans More Aggressive than Manufacturers

A majority of retailers reported they expected to use case-level tagging by the end of 2004. The difference between retailers' expectations and manufacturers' expectations is clear. More than 70% of retailers expect to be rolling out full implementation of Auto-ID by the end of 2005, whereas 75% of manufacturers expect to achieve rollout at the end of 2006 (IBM Global Services, 2003).

When asked at what level they will be tagging their assets in the next two years, more than half of the respondents indicated they would be tagging at the case level or item level in the next two years. This indicates they will not start with pallet-level tagging and progress to lower levels; instead, they will go straight to the lower level of tagging to obtain the greater benefits (Accenture, 2003).

ADOPTION CHALLENGES

The primary challenge cited by respondents was the adoption of the EPC standard. Confusion exists around the objectives and synergies of the EPC and Global Trade Item Number (GTIN) and the work the standards will play in driving toward a common, global standard (IBM Global Services, 2003).

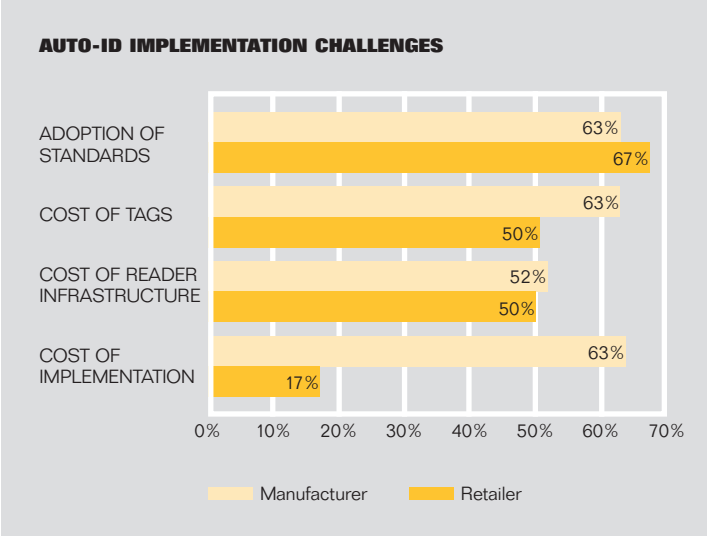

Figure 4: Cost of Implementation the Key Challenge

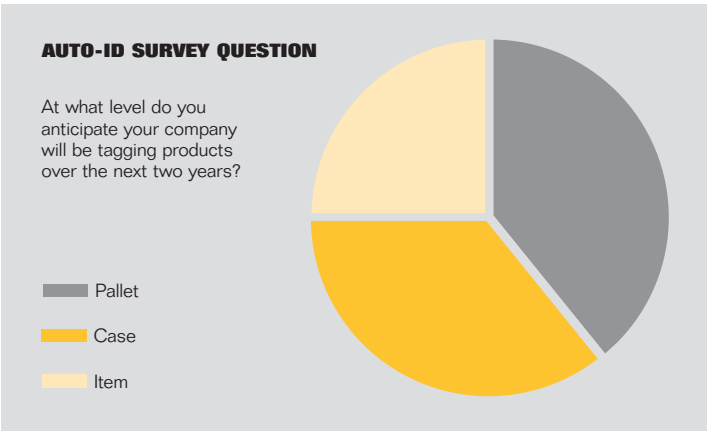

Figure 5: Item-Level Tagging Approaching Sooner than Expected

INDUSTRY PROBLEMS AND HOW AII SOLUTIONS CAN HELP

The following examples illustrate common problems and how AII can help solve them.

PROBLEM: MASSIVE INDUSTRY WRITE-OFFS

Short shipments, unsalable products, and product returns result in billions of dollars of industry write-offs each year. Deliveries that are on time, free of damage, and contain the correct order quantities, products, and shipping documentation arrive to customers only 40% to 60% of the time (IBM Global Services, 2002). Incorrect orders lead to increased customer claims, time spent on investigating claims, inaccurate inventory levels, increased customer returns, and lower customer satisfaction. In-store shrinkage also costs retailers 1% to 3% of their total annual sales. The U.S. Chamber of Commerce estimates that theft ranges from 5% to 7% of world sales when counterfeiting is included.

SOLUTION

Currently deployed RFID systems are already helping CPG companies to increase the accuracy of their order processing, fulfillment, and tracing. AII can associate each item with its manufacturer, distributor, warehouse, shipment, and delivery location. This enables companies to identify, and manage, and track each item as needed – from updating the product's pricing, distribution instructions, and promotional information to managing product returns and recalls. In addition, an integrated Auto-ID system can monitor every tagged product within a store and deliver potential-theft alerts to mobile devices carried by store personnel, helping to lower shrinkage in stores. Because RFID tags are extremely difficult to counterfeit, embedding a unique tag in every product makes counterfeiting virtually impossible.

PROBLEM: RUNNING OUT OF STOCK

Running out of stock costs retailers billions of dollars every year. In many cases, store personnel are unaware of a current or potential out-of-stock condition and consequently do not place an order. In other cases, the product is actually in the store but remains in the warehouse or a back room due to an information gap in the replenishment process.

SOLUTION

Through an enterprise visibility portal integrated with AII, a company can see in real time the changes in inventory occurring at a retail site that uses RFID technology. Consumer products are moved in and out of a smart shelf with an RFID reader on each shelf, causing the inventory count for that storage location to increase or decrease. An inventory early-warning agent monitors the inventory activities for each product at a storage location and compares the actual activities to planned activities. The agent then determines the probability of a stock-out condition occurring within the replenishment time frame. If the probability of running out of stock exceeds a preset threshold, the agent software sends a warning to a replenishment application regarding the timing of the predicted stock-out and the amount of product that would be required to avoid the stock-out condition. The replenishment application then uses the quantity in the agent warning as a demand signal to trigger vendor replenishment, communicates the requirement through AII, and plans the replenishment accordingly. The replenishment order is inserted in the production schedule. When the order is executed and delivered, the replenishment loop is closed.

PROBLEM: NO REAL-TIME ALERTS OR EXCEPTION MANAGEMENT

More than 75% of inbound shipments for a CPG company – and often less than 10% of inbound shipments for a retailer – use automated electronic advance shipping notices (ASNs) or alerts that are fully realized and processed (IBM Global Services). Studies have shown that companies reduce receiving time by 67% by using electronic ASNs on shipments (IBM Global Services). When as much as 30% of a manufacturer's revenue comes from a single large retailer, small logistics snags – such as shipment delays or wrong or incomplete orders – can lead to amplified problems. To catch minor problems before they compound, companies can use event management software and inventory early-warning agents that not only provide real-time notification of shipment delays, but also offer scenarios for diversion in transit. By assigning priority levels to alerts – like code red for anything that threatens fulfillment to a top customer – manufacturers can prioritize problem escalation.

SOLUTION

Integrating AII with exception-handling agents and supply chain event management software helps resolve unexpected logistics problems through management by exception. Residing at individual retail, manufacturer, distribution center, and shipment locations across the network, exception-handling agents are notified by AII of a developing exception. Alerts can be triggered by individual events, such as a critical change in temperature or status, a carrier notifying a retailer by cell phone of an accident or delay, or unexpected inventory shortages or surges in demand. By analyzing the bottleneck in real time, the agent software can recommend the best course of action and redirect tasks to match the needs – taking into account both local constraints and the shared business objectives of stakeholders.

PROBLEM: NO IN-TRANSIT SHIPMENT VISIBILITY

Lack of in-transit shipment visibility and exception alerting causes problems for logistics professionals. Although Auto-ID-tagged items can be read as they leave or arrive at a particular site, the only way to fully guarantee that the items are actually loaded onto a particular truck, ship, or train is to track them while in transit or as they are loaded onto the vehicle. Otherwise, items can be removed or tampered with after they leave their site of origin.

SOLUTION

Visibility and exception alerting provide real-time information that leads to better customer service. Every shipment can be equipped with an RFID reader linked to an existing cellular or GPS network. The RFID reader communicates the status, contents, context (such as temperature), and location of the shipment to local and regional AII installations. This allows all authorized subscribers – from manufacturers to customers – to see the relevant information in real time and react accordingly.

PROBLEM: INCOMPLETE PRODUCT, SERVICE, AND MAINTENANCE INFORMATION

Manufacturers often have very little if any historical information on the equipment they need to service. Thousands of hours are spent every year manually looking up historical maintenance, service, and parts information, and unnecessary spare-parts inventory is routinely carried to service sites. Field technicians rarely know the availability or location of spare parts – or even what parts may need to be replaced – until they manually inspect the unit that needs to be serviced. This lack of information slows service times substantially, due to waiting for deliveries of replacement parts and upgrades. The end result of slower customer service is reduced customer satisfaction.

SOLUTION

Computers, servers, mainframes, utility equipment, telecommunications equipment, cars, trucks, and more can be embedded with unique product information on a bar code or RFID tag. The field service technician can scan the tag with a mobile reader (or a fixed reader at an automobile service center, for example) to transmit the tag data to a central AII server, which contains all the relevant information about parts, service, and maintenance for the particular unit being serviced. The technician can check parts availability in the AII system and find out in real time all the details about the parts to replace and the maintenance contract. If the mobile reader is unable to connect to the central database from the service location, the technician can temporarily store the tag information on the mobile device, synchronize and update the data when a connection becomes available, then provide the appropriate service to the customer. The end result is faster service and increased customer satisfaction.

PROBLEM: MANUAL PROCESSES

More than half of all CPG firms conduct most of their logistics activities in person or over the phone, and many show no signs of changing their methods. Most CPG firms dedicate less than 5% of their logistics budgets to investing in new applications and devices, yet labor costs range from 50% to 89% of overall costs at distribution centers – and 30% of all labor is tied up in receiving alone (IBM Global Services).

SOLUTION

RFID readers installed at the loading and receiving docks of manufacturers, distribution centers, and retail outlets enable complete automation of order shipment and receiving, as well as automated confirmation of every item that is shipped and received. Auto-ID tagging just at the pallet level and case level, without the expense of per-item tagging, can also provide substantial benefits. Order status, shipment, and receiving information can be aggregated by AII and shared with the manufacturer, distributor, distribution center, and retailer as each event occurs – with automatic updating of order replenishment and management systems and also financial systems. Networked Auto-ID solutions can eliminate manual shipping, receiving, and verification processes. SKUs and quantities can be checked automatically against purchase order expectations, reducing check-in time by 60% to 93% and reducing verification costs by 90% (IBM Global Services).

PROBLEM: BLIND PHYSICAL WORLD

Most companies have software for route optimization and inventory management, yet they still have difficulty getting products to the right place at the right time. And many companies have manufacturing monitoring systems, but not an integrated information system that communicates the status of each item across all relevant applications. The problem is that most of today's technologies overlook real-world logistics – the physical assets of shipments, stores, warehouses, and distribution centers.

SOLUTION

Integrating tagged smart items with a universal RFID infrastructure such as AII serves to bridge the digital divide between people, real-world assets, and information technology environments. With AII, authorized subscribers can view and manage item-level information. Smart-item information is available anytime, anywhere, creating an extended environment for making decisions and taking action. For example, with AII, smart sensors and agents can monitor operational conditions such as temperature; flag exceptions as soon as out-of-bound conditions occur; then synchronize with production control agents to recalibrate production.

PROBLEM: EMPTY TRUCKS

Each year, carriers travel billions of miles with no freight on their trucks. Full-pallet shipments are almost nonexistent for retailers and are declining for manufacturers. Currently, only 40% to 60% of total cases shipped are full for CPG manufacturers, and less than 5% of cases shipped are full for retailers (IBM Global Services). Empty miles and incomplete shipments, which occur when carriers can't find goods to haul on return trips or when they pick and ship incomplete orders, cause billions of dollars of wasted capacity every year.

SOLUTION

The solution is an integrated AII deployment involving third-party logistics providers, distribution centers, warehouses, manufacturers, and retailers. With this integrated AII system, manufacturers can communicate to all receiving locations in advance of each shipment – providing information about planned shipments, shipment timing, planned routes, and capacity. Also in advance of each shipment, manufacturers can obtain information on items to be shipped or returned from each shipment location and obtain appropriate authorizations for backhauls and returns, thus minimizing empty trucks. In addition, AII enables manufacturers and retailers to identify and manage each case and pallet, so they can pick the correct case and quantities, then register and verify those items for particular customer orders.

PROBLEM: INCOMPLETE CUSTOMER DATA

Many retailers can't access customer records at the point of sale (POS) today and have not Web-enabled their POS systems. The inability to link cash registers to corporate customer data in real time reduces retailers' ability to provide instant promotions for their customers or to provide cross-selling or up-selling opportunities for their sales personnel.

SOLUTION

To get preferential treatment, customers can use their loyalty cards, RFID tags, or bar-code tags on a key chain to identify themselves, either as they enter the store or when they're checking out. EPC and RFID technology enable companies to identify consumer behavior and preferences in real time – iden-

tifying, for example, what paths consumers take in proceeding through the store, what items they pick up and put back on the shelf, what items they select in their place, which end displays are the most effective, and what behaviors are driven by promotions.

AII can associate customers with their purchasing history and the frequency of their store visits. This enables sales personnel to offer customized and relevant products and services, make instant cross-selling and up-selling suggestions, and offer instant promotions.

PROBLEM: PROPRIETARY, NICHE SOFTWARE SOLUTIONS

Most of today's RFID applications are designed and deployed in isolation from one another and are based on a variety of technologies, vendors, and standards. Most of the existing software solutions are stopgap solutions built by RFID hardware vendors to meet basic customer needs. These isolated custom applications are difficult to integrate, thus making it difficult for companies to realize the maximum value of the information across the value chain.

SOLUTION

AII data models are extensible and dynamic, enabling on-the-fly integration with current and future information types and enterprise applications. Because it uses standard data models such as EPC and PML, AII enables businesses to realize the full value of their existing RFID investments and to leverage that value in business relationships throughout their value chain.

PROBLEM: CUSTOMS PROCESSING AND SECURITY

The enactment of the North American Free Trade Agreement (NAFTA) and the establishment of the World Trade Organization (WTO) were signposts of the economic globalization that is increasingly shaping the U.S. economy. U.S. international trade increased markedly between 1994 and 2000, with imports doubling from $60 billion to $125 billion. Each year, 500 million people, 125 million vehicles, and more than 20 million import shipments enter the United States. More than 16 million containers arrive in the United States by ship, truck, and rail annually. In 2001, U.S. Customs processed more than 214,000 vessels and 5.7 million sea containers. Before September 11th, an estimated 2% of the 16 million containers that entered the United States annually were physically inspected. One problem is that while the volume of trade doubled during the 1990s, customs inspection personnel increased by only 7%. U.S. Customs has been trying to screen for dangerous cargo with only three-fifths of the human resources relative to the increased volume of trade.

SOLUTION

AII can act as a networked, real-time Auto-ID asset data repository for trade agencies, customs, participating government agencies (PGAs), and defense and security agencies – as well as for authorized external stakeholders such as importers and exporters, trade expeditors, foreign PGAs, shipping and logistics service providers, retailers, and manufacturers.

After cargo, containers, handling units, and other trade assets are tagged with Auto-ID tags, AII can track the time items were sealed, shipped, delivered, processed, and received. Manufacturers can write information on the tags to facilitate trade processing – such as shipment handling and storage instructions, proper price and tariff information, manufacturer and receiver IDs, and security clearance and processing codes. AII can make the assigned asset information available to authorized users and applications, thus facilitating automatic tracking, tracing, securing, processing, delivery, and receipt of the assets.

The benefits include total shipment visibility and advanced shipment awareness; increased tariff and pricing compliance; improved identification and interception of counterfeit and hazardous assets; and improved sharing of asset data among all agencies and users.

AII AND SAP APPLICATIONS

The secure, reliable, and real-time data and communications capabilities of AII can add substantial value to multiple SAP applications. AII is also capable of integrating and working within any non-SAP IT environment or with any enterprise application. AII provides a single point of integration for all applications and serves as the recipient of hundreds of Auto-ID transactions per second. AII provides a real-time, synchronized view of every smart item throughout the entire value chain, maximizing the value of every application that uses Auto-ID data.

ADVANCED PLANNING AND OPTIMIZATION

Real-time smart-item data and bidirectional communications throughout the supply chain will substantially enhance the capabilities of SAP® Advanced Planner & Optimizer (SAP® APO). Using AII with SAP APO will increase forecasting accuracy, improve order fulfillments and inventory replenishments, and improve new-product introduction cycles by ensuring that products are always available.

SUPPLY CHAIN EVENT MANAGEMENT

One of the biggest challenges in implementing supply chain event management (SCEM) is ensuring that business partners comply with sending event messages. An RFID infrastructure removes one element of human inattention from the supply chain – a person must trigger an event that can easily be captured by an RFID reader. In addition, enterprises can use SCEM with AII to enforce vendor and partner compliance with key dates in the inbound supply chain, such as ASN receipt, exit-country date, delivery date, and so on.

The SCEM capabilities of mySAP™ Supply Chain Management (mySAP™ SCM) can fully automate the management and execution of routing business events and transactions between business partners. mySAP SCM needs up-to-date and reliable information on all enterprise assets that are affected by each event. If the SCEM software triggers an event – such as replacement of an expired product – based on incomplete data, the result may be unnecessary or incomplete orders and transactions. Auto-ID provides information that can help SCEM software to process events in a rapid and meaningful way.

TASK AND RESOURCE MANAGEMENT

For a company to achieve the full value of a task and resource management (TRM) solution, such as the TRM capabilities in SAP software, every asset, handling unit, machine, and person must have the most current information on the required tasks and locations, as well as accurate instructions for each asset as it flows through a distribution center or warehouse. AII receives and publishes current information on smart items, such as the most recent information on routing, product configuration, resources required, storage, and maintenance instructions. In this way, AII ensures that each task assignment is based on reliable and synchronized data. This supports accurate operations monitoring in real time, automatic confirmation of tasks and transfer orders, automatic task creation, real-time exception management, smooth inventory flows, accuracy in task assignment and completion, and complete automation of material flow systems.

WAREHOUSE MANAGEMENT

AII allows real-time access to current information about the location and status of every asset in a warehouse and to the customer information associated with each asset. This means the warehouse management capabilities of mySAP SCM will be able to further automate inbound and outbound delivery processing, transfer orders, inventory documentation, and processing and shipping. In addition, mySAP SCM will be able to publish the up-to-date information on assets to any application, device, or worker. Integrating and synchronizing various warehouse management information sources – such as scale and conveyor data, RFID and mobile communications hardware, voice systems, production control, and bar codes – will enable companies to further leverage the value of their investments in IT and process automation.

PRODUCT LIFE-CYCLE MANAGEMENT

Manufacturers will increasingly tag their products and components at the point of manufacture. On each tag for each product, they will write all the associated information on parts, maintenance, production dates, expiration dates, pricing, and configuration. By tagging in this way, organizations will be better able to service, maintain, and manage their products throughout their entire life cycle, from manufacture through end of life. mySAP™ Product Lifecycle Management will take advantage of AII to arm field service technicians, manufacturers, and service organizations with all the associated history, warranty, spare-parts availability, and service requirements for each asset. The result will be substantially improved spare-parts availability, maintenance, and quality of customer service.

MOBILE SUPPLY CHAIN MANAGEMENT

Online and offline mobile devices that are capable of reading Auto-ID data will gain widespread acceptance. The need will increase to accurately store, associate, synchronize, and update all the information associated with smart items. Not all smart items will be located within the reading range of an RFID reader or within a wireless network coverage area. To solve this problem, SAP will integrate AII with the mobile supply chain management capabilities of mySAP SCM. This will enable offline reading and writing of Auto-ID data on smart items as well as online synchronization once the device reenters a wireless network or is connected to a corporate network. Both the mobile device and mySAP SCM will have the most up-to-date information on the smart items.

POTENTIAL BENEFITS TO THE VALUE CHAIN

The following table summarizes the potential benefits to the value chain of Auto-ID data integrated with the Auto-ID infrastructure. It estimates the value of tagging goods from the point of manufacture through distribution, sales, and returns. It also estimates the financial benefit to participants in the value chain – from the manufacturer to the consumer.

Value For	Business Process	Benefits	Potential Savings[1]
Manufacturing			
M	Inventory management and logistics	■ Reduced order lead times and errors ■ Inbound and outbound order visibility ■ Better capacity utilization ■ Less shrinkage and loss ■ Gray-market tracking	■ Save the 0.22% to 0.73% of annual revenues that is typically lost on theft ■ Reduce transportation costs by up to 3%
M, R, C	Production	■ Better capacity utilization and sequencing of materials ■ Improved product quality and fewer errors ■ Tracking of work in progress for production components ■ Better subassembly identification and tracking ■ Automatic component matching and assembly ■ Improved recipe management ■ Faster order cycles ■ Improved building to order and building to demand ■ Reduced counterfeiting	■ Increase revenues up to 1% by improving product quality and service ■ Reduce fixed-asset costs by 1% to 5% as a result of better equipment utilization ■ Gain 7% in margin by tagging at the subassembly level ■ Gain 12% in margin by tagging at the pallet level ■ Gain 18% in margin by tagging at the shipping-unit level
M, R, C	Maintenance and service	■ Better tracking of warranties, service, end-of-life processes, spare-parts, and recalls ■ Improved maintenance and repair through increased parts visibility and correct part IDs ■ Easier tracking of life spans and expiration dates for managing asset returns	■ Avoid the erosion of nearly 30% of potential annual revenues that is caused by markdowns on old or unsalable inventory
Warehousing			
M, R, L	Receiving and shipping	■ Automated processing of loading and unloading ■ Reduced labor requirements ■ Faster processing ■ Automatic cross-docking ■ Automatic generation of 100% accurate electronic manifests	■ Reduce receiving costs by 20% to 30% ■ Reduce shipping costs by 15% to 25%
R, L	Product storage and selection and order fulfillment	■ Correct product storage locations ■ Faster product retrieval ■ Fewer order errors ■ Reduced losses and shrinkage of assets ■ Improved order fill rates and times ■ Less safety stock required	■ Reduce picking costs by 40% to 50% ■ Reduce working capital by 8% to 12%
M, L	Task and resource management	■ Automatic updating of tasks for each resource ■ Improved automation and accuracy of flow control ■ Improved real-time monitoring of operations ■ Automatic conveyance and sorting ■ Automated and accurate picking and packing	■ Increase cross-docking by 45%

Table 1: Potential Benefits of Auto-ID Data Integrated with the Auto-ID Infrastructure

M= Manufacturer
L= Logistics provider
R= Retailer
C= Consumer

1) Savings will vary by industry, application, product, and level of tagging. These savings are general range estimates for various industries based on SAP estimates, discussions with customers, and industry reports.

Value For	Business Process	Benefits	Potential Savings
Transportation			
M, L, R	Asset management and routing	■ Increased asset utilization ■ Reduced loss and shrinkage ■ Pricing based on actual asset usage ■ Reduced labor costs ■ Optimized route planning and backhauling ■ Automated advance shipping notices	■ Achieve 25% to 40% higher profits due to improved logistics for returns ■ Speed pickup and delivery by 10%
L	Yard management	■ Visibility of drop shipments ■ Automatic identification and location ■ Increased throughput	■ Reduce labor costs by 30% ■ Reduce demurrage by 60% ■ Increase throughput by 20%
M, L, R	Contract compliance	■ Decreased errors and exceptions ■ Improved customer service	■ Reduce bad-data costs by up to $100 million ■ Reduce claims from lost packages by 98%
Store Operations			
M, L, R	Receiving	■ Faster load processing ■ Automated shipment confirmation and payment ■ Improved order accuracy and less shrinkage	■ Reduce labor costs by up to 65%, stocking costs by up to 25%, and cycle counting by up to 25% ■ Reduce losses due to theft by 40% to 50%
M, R	Store planning and inventory management	■ Improved on-shelf availability of products ■ Correct product compliance with the plan-o-gram ■ Mobile inventory tracking, velocity measurement, and monitoring ■ Improved product turns and shelf-life management ■ Out-of-stock notification and alerts ■ Multichannel retailing ■ Automatic compliance with expiration dates and recalls ■ Automatic inventory counts ■ Less labor and time	■ Improve stock availability by 5% to 10% ■ Increase sales by 3% to 7% due to improved stock availability ■ Reduce spoilage and obsolescence write-offs by up to 20%
M, R, C	Checkout	■ Faster and more accurate checkout using Auto-ID ■ Instant sales data by SKU and EPC ■ Higher productivity and less labor ■ Instant cross-selling and up-selling and promotions to member customers ■ Improved customer satisfaction	■ Increase customer retention by 0.3% to 0.5%
R, C	Returns and reverse logistics	■ Prevention of fraud in returns ■ More accurate return refunds ■ Faster disposal and backhauling	■ Increase revenue by 1% to 2% due to improved returns management
M, R, C	After-sales support	■ Automatic warranty information associated with each item and personalized for each purchase ■ Better warranty compliance and repairs processing and reduced errors	NA

M= Manufacturer
L= Logistics provider
R= Retailer
C= Consumer

The following figure illustrates the benefits of using Auto-ID data and the Auto-ID infrastructure throughout the value chain.

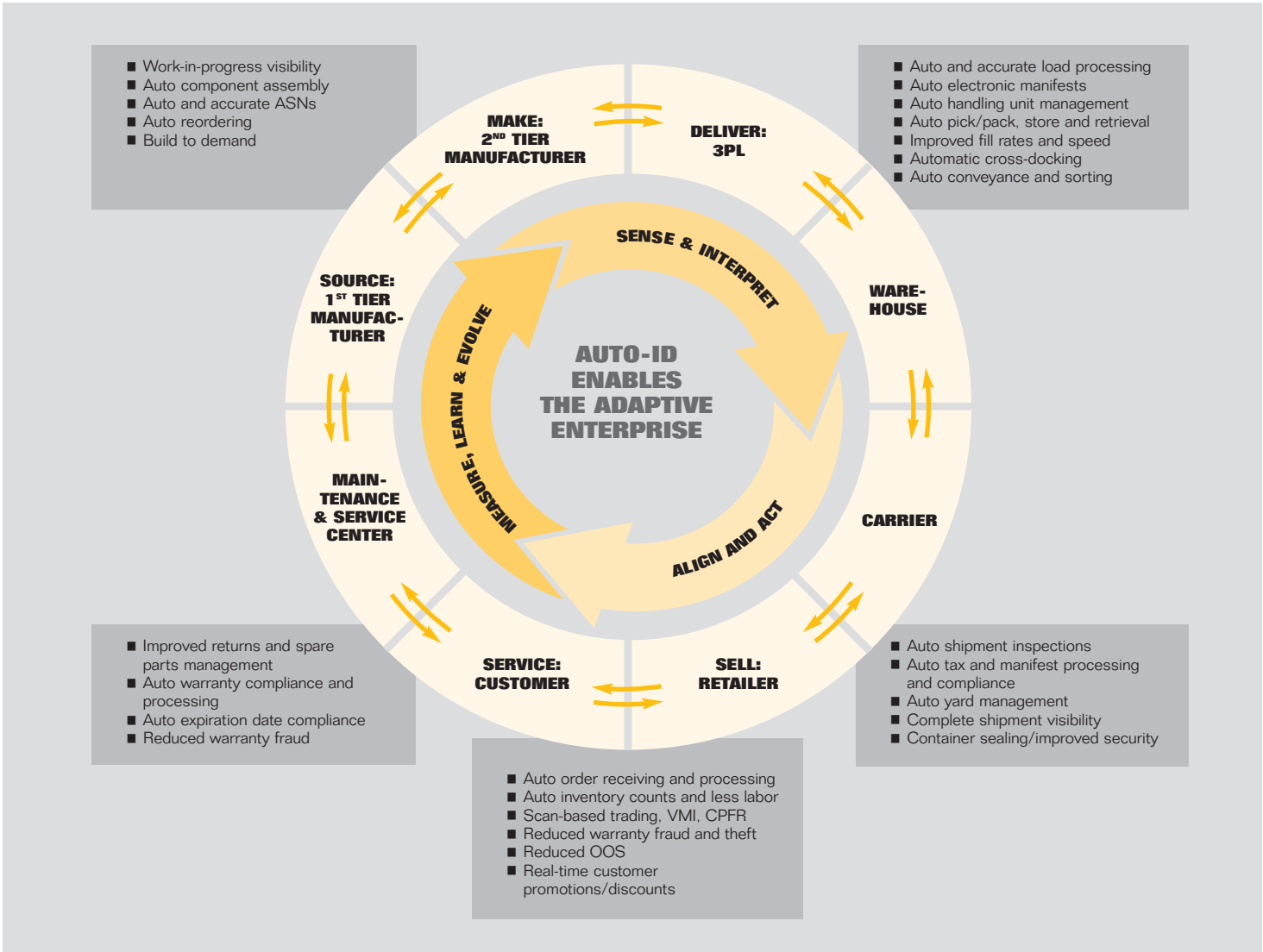

Figure 6: Auto-ID Infrastructure Benefits from Manufacture Through Maintenance

AII TECHNOLOGY

The following is an overview of AII technology and how it works.

CORE COMPONENTS OF THE AUTO-ID INFRASTRUCTURE

The following core components are required in a complete, end-to-end Auto-ID infrastructure that solves a variety of Auto-ID data management problems – from data filtering and modeling to bidirectional, real-time communications and control.

Association Model

The core of AII is the association model. At any given instant, the association model contains a representation of the state of the environment and the associated information, as seen by the RFID readers and other data-gathering systems in the sensor network. The association model includes a framework representation of the business, logical, and physical world that is being monitored.

Enterprise System Adaptor

The enterprise system adapter is responsible for bidirectional communication and integration with SAP and non-SAP enterprise systems. The adaptor is lightweight and serves as the bridge between the enterprise system and the global information bus.

Global Smart-Items Data Engine

The global smart-items data engine is responsible for maintaining a global view of all smart items that are tracked and their histories, locations, and relationships to enterprise structures. It is also responsible for mapping and integrating smart-item data into enterprise systems when necessary.

Local Smart-Items Data Engine

The local smart-items data engine has the same structure as the global smart-items data engine, but it maintains a local view of the system. Multiple local smart-items engines are all connected to the global information bus.

Global Information Bus

The global information bus is a centralized hub that is responsible for integrating multiple enterprise systems and applications with smart-item data. The global information bus supports the exchange of business-to-business documents and transactions based on a publish-and-subscribe model or a real-time, point-to-point communication model. SAP® Exchange Infrastructure may be used for this function.

Local Information Bus

Similar to the global information bus, the local information bus is based on a publish-and-subscribe and point-to-point communication model. However, this bus supports the exchange of data and controls messages at a local level. The bus must be optimized for high message rates and minimal delay. The local information bus aggregates data messages and routes them to the desired recipients based on static and dynamic rules. However, the responsible control engine or data engine can also perform data management at the component level.

Control Engine

The control engine coordinates the actions of multiple devices through their simple device controllers and network device controllers. It also performs some simple data filtering. The control engine can be configured to access the device controllers through the local information bus. Alternatively, when real-time information is required, the engine can be configured to access the device controllers directly (through serial ports, specialized networks, or other means).

Simple Device Controller

A simple device controller manages a specific, single device such as an RFID reader through a hardware abstraction layer. It serves as a proxy for the device. Current SAP demos have all used this type of controller to generate events onto the information bus.

Network Device Controller

The next generation of sensors and readers can be plugged directly into the network and are immediately functional (they are plug-and-play devices). The connected reader can be discovered, configured, and controlled by a control engine through the local information bus. Basically, a network device controller is a simple device controller plus the corresponding sensors in a single piece of hardware.

Data I/O System Adapter

The data I/O system adapter allows integration of the smart-items data engine with existing automation and control systems at the local level. These include systems for production control, task and resource management, and quality control, as well as third-party systems for specialized functions.

HOW DOES AII WORK?

The following is an overview of how AII works.

Event Capture

The sensor network acquires data from RFID tags, bar codes, GPS, or other sources of real-time enterprise data. A typical event is a message indicating that a specific EPC was detected by a particular RFID reader (the RFID reader is also uniquely identified by an EPC). The message includes a disposition status indicating whether the item entered, exited, was sensed as part of an inventory check, and so on. Other typical events are periodic updates of the locations of moving transport vehicles; receipt of links to business documents associated with specific items; traditional bar-code reader events; and in general, any dynamic information about the location and status of any smart item.

A primary architectural goal is for the sensor network layer to shield the association model from any hardware peculiarities. For example, retail "smart shelves" can be built in many ways and by a variety of vendors. With AII, control and configuration software that is vendor-specific is associated only with the hardware; a consistent, vendor-independent protocol is used for reporting shelf contents. Any data filtering that is specific to a local circumstance is performed locally.

Association Model

A high-level AII system supporting cross-enterprise goods movement in the consumer packaged goods industry contains a representation of each participating manufacturer, distribution point, delivery service, and retailer. The representation is hierarchical and leads down to the geographical coordinates of each location. Bottom-level, leaf-node implementations of AII include the detailed structure of each monitored storage location; the location and type of each RFID reader; a representation of specialized storage locations such as smart shelves; and a representation of transport-based storage locations, such as trucks with a GPS and tagged shipping containers.

Simple Item Movement, Tracing, and Tracking

A typical simple event coming into the association model identifies the ID of the item sensed, the ID of the sensor, and a disposition, such as "entered," "departed," "sold," "inventory check," and so on. The association model also associates sensors with specific storage locations. Thus an individual item can be listed with a specific designation for its physical storage location. As an item moves within a warehouse or onto a truck, the association model maintains a precise listing of its logical and physical location and status.

Shipment Creation
It is generally valuable to have RFID tag information at each packaging level, including at the item, case, pallet, and handling-unit levels. It is very important to be able to relate information such as the order number and shipment number to any level of packaging as well as to individual items. When a pallet moves off a truck onto the loading dock, the system should automatically identify the shipment, with no need for paper processing. The RFID sensors should be able to validate a shipment precisely, with no need to open the packaging or perform manual effort.

When a carton is packed as part of a shipment, the association model stores the ID of the carton, the IDs of each of the contents, and the shipment number or its equivalent. The tag information can all be read automatically by an RFID reader. The shipment number may come from a bar code, from manual entry, or from a logistics execution system. The association model constructs a hierarchical model of the shipment, carton, and items. The carton may be combined with others on a pallet, which also has an ID. When a pallet is moved by forklift onto a truck, the association model reflects that the pallet has been loaded onto the truck along with each of its cartons and the individual items within each carton.

Basic Information Retrieval
The internal structure of the association model is engineered to optimize retrieving information in a natural way with minimal cost. Given an item's ID, its location can be found directly. Given a location, all the associated items can be found directly. Given any item type (SKU), the location and disposition of all the individual items can be found.

These basic retrieval mechanisms are very powerful. If a specific tagged vial of medicine must be recalled, the association model can immediately identify its location in a warehouse, at a pharmacy, or on a specific truck. If the truck is fitted with a GPS or other mobile tracking and tracing information system, the association model will know the truck's precise geographical location.

Location Awareness and Retrieval
The association model knows the precise geographical location of each sensor. All items are assumed to be in the vicinity of their most recent detection by a sensor. The association model can provide all needed information to a geospatial mapping system for visualizing the flow of a supply chain and for identifying stock with various geographical criteria. The applications are numerous – making it possible to find out, for example, the location of Duracell batteries within 100 miles of Seattle; which planned shipments will be impacted by a closure of the interstate highway through Colorado; or the location of certain products that need to be recalled.

CONCLUSION

Smart items will continue to increase in number and complexity across entire economies and countries. The volume and velocity of communications between smart items – as well as communications between smart items and machines, networks, mobile devices, and enterprise applications – will compound substantially. The demands on data management and communications will far exceed the capabilities of today's best IT systems. Smart items create an entirely new communications media between assets, applications, and machines. Single, point-to-point integration of smart-item data into current and future enterprise IT environments is neither financially sound nor technically scalable. The SAP Auto-ID infrastructure provides the platform for companies to leverage their current and future investments as they track and share Auto-ID data throughout their products' life cycles and across their value chains.

CONTACT INFORMATION

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RELATED INFORMATION

AIM: The Association for Automation Identification and Data Capture Technologies
www.aimglobal.org

Auto-ID Center
www.autoidcenter.org

Autoid.org
www.autoid.org/

AIAG: Automotive Industry Action Group
www.aiag.org

EAN International
www.ean-int.org

M-Lab: The Mobile and Ubiquitous Computing Lab
http://www.m-lab.ch/

UCC: Uniform Code Council
www.uc-council.org

U.S. Department of Defense Logistics Automatic Identification Technology Office
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