EPC Technology in the Retail Supply Chain

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Wireless Internet for the Mobile Enterprise Consortium (WINMEC)
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Abstract

The purpose of this white paper is to provide a survey of the effects of EPCglobal standards, including Electronic Product Code (EPC) and Physical Markup Language (PML), on manufacturing, distribution, and store operations in the retail supply chain. Retailers assign a unique EPC to items in inventory and employ PML to tag data about the item before transmitting it over the network. Once RFID tag prices drop and firms implement ERP software capable of processing Auto-ID data, EPC and PML technology is expected to spread throughout the retail supply chain, decreasing costs and increasing revenue through improved operations, increased labor productivity, and enhanced customer service.

Introduction

Radio Frequency Identification (RFID) tags are currently being used to automate processes in the retail, manufacturing, automotive, and shipping industries to facilitate product identification and direct workflow automation. An Automatic Identification (Auto-ID) technology, RFID tags relay data to remote readers, transmitting encoded information.

The technology is currently being deployed within firms or in customer-supplier relationships to facilitate supply chain operations where RFID integration can be closely managed. However, with the development of cheaper tags and improved information technology systems, RFID is expected to grow in popularity. Retailers like Wal-Mart have already mandated that top suppliers implement RFID by 2005, and groups like the MIT Auto-ID Center have designed passive tags that do not require an integrated battery supply on the chip, lowering the cost of the tags to less than five cents. As more firms adopt RFID technology, the need for systems integration enabling partner firms to coordinate supply chain management will increase.

What is EPC?

Developed by the MIT Auto-ID Center and tailored to Global Trade Item Number (GTIN) standards, the EPC is a 96-bit unique identifier that consists of a header followed by three numerical sequences. The 8-bit header includes the EPC version number; the first 28-bit sequence identifies the product manufacturer; the second 24-bit sequence identifies the type of product, most often the Stock Keeping Unit (SKU); and the third 36-bit sequence identifies the product serial number. Overall, one quintillion \((10^{18})\) possible EPC combinations are available for use, making item-level and even part-level tagging a viable option. EPC codes can be assigned to machinery, equipment, supplies, pallets, cases, items, item parts, and even personnel – in essence, an EPC can be assigned to any object that can be tagged.

The EPC is embedded on a chip that resides in an RFID tag. The tag itself is scanned by a radio-frequency reader and this information is routed to the Object Naming Service (ONS) that identifies where information about the object can be located on the network. Information about the object is encoded in PML, analogous to HTML for text on the Web. Item properties like weight, ingredients, and expiration date are recorded in the PML file. Middleware, software used to translate data between the reader and the network, uses this data to control manufacturing processes, tally inventories, or track product location, among other possibilities.

RFID software standards were developed by the Massachusetts Institute of Technology’s Auto-ID Center and are currently managed by EPCglobal, a joint venture between EAN International and the Uniform Code Council (UCC). As the international standards body that oversees EPC industry standards, EPCglobal also manages the ONS EPC registry. With mass adoption of EPC technology by industry, the standards are expected to evolve. Currently, EPC technology has the potential to ignite a change in retail supply chain operations.
EPC in Manufacturing

Process Automation

With EPC technology, time can be saved through automated monitoring of raw materials, work-in-process, supplies, and other items associated with the production process. Inventory quantities and locations are transparent if each item is tagged and registered as it enters the factory floor. Sensors posted at dock doors register the arrival of new materials, obviating the need for time-intensive and error-prone hand or typewritten entry of asset information. Manufacturers who utilize scanners to record barcode numbers also experience improved accuracy, as problems associated with barcode misreads, lost packages, and lost labels are removed. This is particularly important in receiving departments where thousands of incoming shipments are tracked every day. With full EPC implementation, personnel can focus on planning and other operational tasks.

Sensors located throughout the factory floor can detect the locations of assets and ingredients in work-in-process. Raw material expiration dates can be monitored to prevent the use of unsuitable components, and alerts can be triggered if two potentially lethal compounds are mixed together or if raw materials incompatible with the finished product are used. The locations of equipment are also continually monitored so that personnel can easily locate assets on a crowded factory floor.

Outgoing shipments can be automatically monitored as well. Pallets and cases of finished product can be tagged and associated with information regarding customers, product destination, distribution method, product quantity, lot number, and other criteria. This information is saved in PML format on the corporate server, enabling personnel to analyze the information at a later time.

Demand Planning

Demand planning is currently difficult because of the lack of coordination between manufacturers and retailers. Retailers provide point-of-sale (POS) information regarding consumer purchases but don’t provide warehouse or in-transit inventory data. Inventory supply inaccuracy also results from human error – items that are not physically scanned do not appear in status reports.

EPC tracking eliminates human error and provides more accurate data. One example involves cycle-counting at retail stores. Stocks of items must be periodically counted to ensure that units in stock accurately reflect inventory levels in the tracking system. “Lost” items are reset to 0, but errors in tracking such items that are actually in the store results in excess inventory and inaccurate baseline levels. Retailers also use “assumed receipt” when tracking new product shipped to the retail store from a manufacturer. By assuming that all products were shipped as specified, the store owner leaves the possibility of a miscount open. With readers installed at receiving docks, product types and numbers are tracked more accurately and efficiently. Such tracking also eliminates the need for extra warehouse capacity designed to retain excess inventory and reduces the need for manufacturers to quote additional lead time to buffer against production uncertainties. In short, EPC technology enables manufacturing that is closer to just-in-time.

Resource Planning and Asset Maintenance

With data garnered from operations on the factory floor, analysts can integrate the information into Manufacturing Resource Planning (MRP) applications. Through analysis of component stock-outs, planners can order larger batches of the ingredient or place more frequent orders. If certain finished goods are disproportionately defective, planners can analyze on a component basis which part caused the product to fail and replace that component with a higher-quality counterpart. Expiration of ingredients can also be monitored and such ingredients reordered automatically through an MRP system integrated with the EPC and ONS servers.

Assets like heavy machinery that are tagged with unique EPC’s can also be monitored to alert staff when maintenance is due on the equipment. Maintenance or repair operations are also facilitated through the tagging of component parts. Finally, an audit trail can be maintained to monitor which equipment is used to create a particular
Quality Control
As components are tagged with unique EPC identifiers, information about lot number, expiration date, manufacture date, and other criteria can be recorded in PML files. Recalled or expired product may be inadvertently used during product assembly, or inexperienced staff may introduce incorrect ingredients into the assembly line. In both cases, the system can alert plant managers that inappropriate materials are being used so that lines can be halted. Thus, quality control departments benefit from the integration of EPC technology into the manufacturing process.

One test of EPC’s capabilities lies in plant audits, where transparency on the assembly line helps firms comply with government and industry regulations. Component state characteristics like temperature, conductivity, and chemical composition can be tracked and associated with the component in its PML descriptor file. The file can be provided to auditors during the corporate review process. The ultimate test of EPC involves recalls when manufacturers must track specific batches of product. Unique EPC’s that encapsulate batch number, manufacture date, or plant number can be used to track these products after they leave the manufacturing floor, and retailers can easily return the encoded product if necessary.

EPC in Distribution
Inventory Management
Inventory and asset management in the yard or delivery lot can be automated, with instant knowledge of which dock doors are free and where trailers are located on the premises. Pallet or case registration can also be automated, as the need to find and manually scan barcodes is no longer needed. With transmitters at loading dock doors, items can be detected and associated with the cargo container or delivery truck EPC. If the pallets or cases require routing during the delivery process – for example, when cargo is transferred from a barge to a truck – readers can detect the EPC’s and corporate servers can look up destination information in the PML repository. Packages can thus be directed to the appropriate truck, greatly reducing the chances of misrouting a delivery.

Quality control in the delivery process will also improve with EPC implementation. Delivery of hazardous products can be smoothed through asset tracking. The routes of tampered packages can be traced to locate the source of tampering so that quick action can be taken to handle contamination. Information about the package like weight can also be recorded and compared to destination weight to ensure that the package is not tampered with during delivery. Finally, delivery routes can be recorded in detail if location history is required by clients.

Delivery
Once the pallet reaches its destination, no paperwork is required to register the transfer of materials, as readers at the receiving dock door automatically detect the contents of the pallet and update manufacturer and retailer inventory databases. Drivers can thus deliver more packages in a shorter period of time. EPC technology can also hasten customs clearance as content information associated with the EPC is compared to information provided by importers.

Granular delivery data can also be used by the delivery company to improve operations. By locating bottlenecks in the delivery process, the firm can move to reduce these bottlenecks and hasten product delivery. Delivery firms can also track volumes more accurately to calculate fees and volume discounts. Customers receive more reliable estimates regarding delivery times and can track their package in transit. The performance of delivery contractors can also be monitored – including delivery times and percentage of delivered shipments – to determine whether or not to continue with that contractor.
Asset Management

EPC codes can be used to track containers – including racks, pallets, trailers, trucks, and even aircraft. With such data, firms can maximize asset use by eliminating or purchasing more containers to manage the delivery load. Low-use containers can be sold and leased during high-traffic times. Maintenance is also simplified via the use of EPC tags on truck and aircraft parts to identify parts that need maintenance or repair. High-maintenance parts can also be identified and replaced if these parts are deemed defective or faulty.

Customer Service

Packages can be assigned unique EPC’s, and data like contents, handling requirements, and other pertinent information can be associated with the EPC in the firm’s PML server. With such data, delivery personnel can tailor package handling procedures to the item and distinguish high priority or sensitive items, like donor organs or vaccines, from less crucial items. Environmental data like temperature can be recorded and associated with the EPC, enabling shippers to keep the package within a specified temperature range and allowing the customer to ensure that the package is indeed delivered under the specified conditions.

Smaller and misplaced packages can be more conveniently monitored since they are detected by readers rather than manually scanned. Cases lost in transit will decrease as a result, and delivery insurance premiums may drop. Transportation firms can also offer services to customers with the help of EPC technology. They can provide retailers links to product information on the Web by associating the item’s EPC code with data provided by the manufacturer. Details on product content and features can be downloaded from the manufacturer, saving the retailer data storage costs.

Process Automation

EPC tags can simplify such routines as the opening and closing of dock doors. For temperature-controlled environments like refrigerated trucks, the automated opening and closing of doors can save thousands in energy costs.

EPC in Retail

Inventory Count

Retailers can use EPC to track inventory levels in real-time. Demand is calculated using historical data and current inventory levels, with adjustments for the effects of advertising and promotion. These demand estimates determine order volumes, but the risk of ordering too much or too little inventory poses risks for the retailer. Maintaining an accurate inventory count enables retailers to determine order quantities with more precision. Currently, retailers make a trade-off between accuracy and cost. They can manually count each item to ensure that product orders match items received and that store inventory records match actual inventory quantities. However, manual processing is often too costly for these firms. Auto-ID readers provide these retailers with accuracy at a fraction of the cost. By installing readers at shipping dock doors, in storage rooms, and on store shelves, retailers can maintain an accurate inventory count.

Product Tracking

EPC technology also enables inventory clerks to track items by indicating whether or not a product is in stock and, if so, where in the store the item is located. Retailers thus save time that would otherwise be spent searching for inventory. Installing Auto-ID readers in storage areas and store shelves or providing employees with handheld devices enables retailers to pinpoint the locations of product in stock. Movement of items from the backroom to sales floor shelves can also be monitored and new orders placed to replenish backroom supplies. Mixed cases and individual items in storage can also be tracked with more granularity.
To monitor inventory availability on the sales floor, individual units can be tagged with unique EPC’s. If a particular item runs out, readers built into shelves can alert employees that a particular item needs replenishing. Customer service will also improve as employees provide clients with immediate information on product stockroom availability. Clerks currently leave customers on the retail floor to check for additional stock in the backroom.

**Customer Service**

Consumer goods on promotion frequently run out of stock at the store, costing the retailer lost sales. However, items that are not stocked on store shelves can often be found in storage or in other parts of the store. Items can be displaced by customers or mis-shelved by employees. EPC readers installed throughout the store can easily locate these “lost” items if they are individually tagged. Readers on the shelves can then trigger alerts to inventory clerks instructing them to restock the shelves, and integrated inventory systems can inform the clerk of where the additional product is located.

**Perishable Goods and Product Recalls**

Products like drugs or food items that have expiration dates place pressure on grocers and pharmacies to remove expired merchandise and restock these items as needed. Readers can again detect individually tagged items and inform clerks if the EPC’s match ID’s associated with expired product in the store database. Clerks can then remove the merchandise, averting a potential crisis. Product recalls are also hastened through EPC technology. Each item retains its manufacturing lot number so employees can pull only those items associated with that number during product recalls.

**Automated Check-Out**

Auto-ID readers can replace check-out clerks in groceries and other retail stores. By automatically scanning all the items in a cart, a reader can detect the prices of the items and pass the information to a system that tallies up the prices and process the shopper’s payment. Such automated check-out will reduce wait time in check-out lines, a source of complaint for many customers. With clerks processing purchases, readers can still reduce the amount of time employees spend looking for barcodes and correcting misread entries.

**Shrinkage**

Shrinkage is reduced through EPC-enabled product tracking. Sensors can detect when unpurchased items are removed from the store and alert security. The presence alone of the tags also deters potential shoplifters. Fraudulent attempts to return items can also be tracked, as PML records can be retrieved during the return transaction. Information like purchase price, time, and location can be displayed; if this information does not correspond to the customer’s complaints, security can be alerted.

**Cost Savings Through EPC Implementation**

In summary, EPC implementation results in higher labor productivity, better resource planning, and improved product and service quality throughout the retail supply chain. Manufacturers lower expenses through process automation, planning, and quality control. Distributors benefit via automated inventory and asset management and reduced physical delivery costs. Finally, retailers benefit via reduced inventory costs, automated product tracking, and improved customer relations.
References