The Explosion of Retail Item-Level RFID: A Foundation for the Retail Revolution

The world's smartest and most innovative retailers are implementing RFID in a big way. Learn why, how, and what it means for Retail.

Authored By: Bill McBeath

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Commissioned by TAGSYS in partnership with ChainLink Research

About ChainLink Research

ChainLink Research, Inc. is a Supply Chain research organization dedicated to helping executives improve business performance and competitiveness through an understanding of real-world implications, obstacles and results for supply-chain policies, practices, processes, and technologies. The ChainLink 3Pe Model is the basis for our research; a unique, multidimensional framework for managing and improving the links between supply chain partners.

For more information, contact ChainLink Research at:

719 Washington Street, Suite 144, Newton, MA 02458.

Tel: (617) 762-4040. Email: info@clresearch.com Website: www.clresearch.com

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The Retail Revolution is Here

Retail is going through huge transformative changes. Retailers, who are typically cautious about technology spending, are taking bold steps, catalyzed by the need to provide full omni-channel integration, a differentiated customer experience, and improved margins. These are enabled by new technology developments in cloud solutions, wireless, mobile, payment, in-store technologies, and RFID.

In fact, RFID is a core foundation that unlocks item-level, context-aware intelligence and utility that is the basis for many of the changes we are undergoing in retail, such as self checkout, location-based services, mobile shopping and promotions, smart mirrors and dressing rooms, warranty management, asset tracking, store management/optimization, inventory management, loss prevention, and much more. This report explains the how and why of this phenomenon, organized in the following sections:

1. *The Retail Revolution is Here*—How RFID enables many of retail's current primary initiatives.
2. *From Source to Store—The Power of End-to-End*—Use cases for RFID across the retail chain.
3. *End-to-End RFID Implementation Examples in Retail*—Two mini-case studies.
4. *Selecting and Creating the Right Foundation*—What you need to know about implementers, solution providers, and solutions architecture.
5. *Appendix A: Criteria for Selecting a Solution*—Detailed criteria for selecting a solution.

Why Retailers Are Seriously Implementing RFID Now

The likes of Walmart, Macy's, JCPenney, Marks & Spencer, American Apparel, and others are finally implementing item-level RFID in a big way. Macy's announced that all 'size-intensive replenishment' items are being tagged, representing about 30% of their total annual sales. Marks & Spencer is tagging all apparel and home goods products at all of its stores. American Apparel is rolling out RFID to all of their stores. JCP is using RFID with about 35% of their merchandise. One high-fashion retailer is rolling out RFID on 100% of their merchandise at all its retail locations and DCs worldwide (for more on this, see *End-to-End RFID Implementation Examples in Retail*). And many smaller retailers are implementing very creative uses of RFID.

Last year, well over one billion apparel items were tagged. That number is expected to rise substantially this year. The benefits of RFID have been known for years, so why the big surge in retail recently? Certainly the prices of tags and readers came down dramatically from where they were 10 years ago. But perhaps even more importantly, pilots have been conducted, lessons have been learned, solutions have matured, and a body of expertise has been built up. The experience gained with RFID has enabled some solution providers to

make quantum leaps in performance, reliability, and implementability. It has enabled retailers and brand companies to understand where and how to use the technology to really make a difference, gaining benefits and ROI. Retailers are using RFID to transform specific processes in a big way to achieve their strategic objectives.

RFID is Foundational to Many Retailers' Prime Initiatives

RFID has proven foundational to many retailers' most fundamental initiatives for competitiveness:

Omni-channel

To survive in 2013 and beyond, retailers need to make it easy for consumers to buy anywhere, receive anywhere, and return anywhere. The key to this cross-channel order promising is the ability, in real-time, to locate and allocate available inventory from any location, whether in the store, in DCs, in transit, or on order from the manufacturer. This requires having a very accurate, real-time, item-level picture of inventory at all these sources. RFID has proven to improve perpetual inventory accuracy in stores dramatically, by 20%-30%. JC Penney improved perpetual inventory accuracy from 75% to 99% in categories using RFID.

UPC to EPC—The Power of Automated Item-Level Visibility

Most retailers use product-level data (UPC – which tells you which product, but not which individual item) for *product identification* and pallet or case-level data for *logistics*. Item level barcode data is usually only read at the origin (manufacturer) and the end of the journey (point-of-sale), but rarely in between. Instead, pallet and case barcodes are read at the handoff points during the journey, with the assumption that the items that are supposed to be in them are there. It is not economical to unpack cases and read item-level barcodes during the journey. Furthermore, barcode reading, whether item-, case-, or pallet-level, is done manually,[1] one label at a time.

With item-level RFID, the manufacturer and retailer have visibility to each unique item throughout its end-to-end journey. This visibility can be provided automatically as goods are loaded and unloaded on vehicles, traveling on a conveyor belt, put on or taken off of shelves, or other movements through the chain and the store (see Figure 1 below). The result is dramatic reduction or elimination of the labor required to capture data, increased data accuracy, and item-level granularity at many more points in the process. The implications are profound. It is this pervasive and granular item-level visibility from RFID that capabilities in the retail revolution.

Figure 1 – RFID Automated Item-Level Reading As Product Moves Through the Supply Chain and Store

[1] The exception is automated barcode readers on conveyor belts. But these require strict discipline around placement and parameters of the barcode label, which when not followed precisely makes the labels unreadable, necessitating manual exception processing.

Increased Sales and Reduced Markdowns

RFID has been shown to reduce out-of-stocks by 20%-30%, thereby increasing sales by 1%-2%.[2] By improving promotion execution, RFID can increase the revenues from promotions by 10%-18%.[3] Furthermore, customer loyalty is improved when shoppers consistently find what they are looking for in stock. The improved inventory accuracy of RFID also lowers the need for markdowns. Sales associates spend less time managing stock and more time providing service to the customer. It is no wonder that we are seeing such enthusiasm for this technology among retailers.

Lean, Cost Control, Profitability

The retail sector has been in transformation in the last decade with consolidations and mergers, rethinking merchandise strategies, new store formats, and consumers changing how and where they shop. Promotional pricing pressures, combined with an uncertain economy, have created a persistent shift to greater price-sensitivity among consumers. This has increased margin pressures on all but the highest-end luxury brands, driving the need to reduce costs on all fronts. There is a renewed interest therefore in lean principles and lowering inventory and labor costs wherever possible. However, inventory has to be reduced intelligently—across-the-board reductions only erode service levels, increase out-of-stocks, and thereby reduce sales.

RFID decreases labor requirements. For example, RFID lowers the manual labor required for receiving by 50%-80%. Inventory cycle counts can be done 10-30 times faster with RFID than current manual methods. Inventory accuracy is improved due to more frequent cycle counting and reduced counting errors. Improving inventory accuracy leads to improved replenishment and forecast accuracy, allowing retailers to intelligently lower inventory levels and *at the same time* reduce out-of-stocks.

Brand Protection

For luxury items, RFID is an important weapon in verifying authenticity. This requires strict security and control over the tags, as well thinking through the supply chain and where in the chain authentication will be done. Further, it requires RFID tag designs that can be very discreetly integrated into the item, yet still perform well. Today, ultra-brands are educating their consumers and building out the systems and infrastructure for distributors, retailers, and end consumers to verify the authenticity of the item using RFID, often combined with other techniques. Luxury brands such as Burberry, de Grisogono, Elie Tahari, Ralph Lauren and others are using RFID to protect their brands and confirm authenticity.

Customer Experience / Differentiation

With intense competition coming from all sides—Amazon and other online channels, Big Box discount chains, and new market entrants encroaching on others' territories—it is more important than ever for retailers to differentiate themselves and provide a unique customer experience. RFID can play a key role here with innovations such as automated/instant self-checkout, easier and more automated returns process, ensuring the right mix is always in stock, freeing up store associate labor (from mundane tasks like stock keeping) so they can have more face-time with the customers, and enabling associates to give rapid, precise and high-confidence answers about what is in stock and where it is. In fact, creative retailers discover new uses for RFID every day to transform the customer experience.

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[2] Source: RFID's Impact on Out of Stocks: A Sales Velocity Analysis—Hardgrave, Waller, Miller.

[3] According to two different studies, by Gillette and by RedPrairie.

From Source to Store—The Power of End-to-End

An end-to-end implementation enables sophisticated and adaptable processes with the supplier, carriers, 3PLs, and retailers. This includes a range of valuable process improvements as illustrated *below*.

Interactive diagram: mouse over processes and supply chain nodes below to highlight the connections between them.

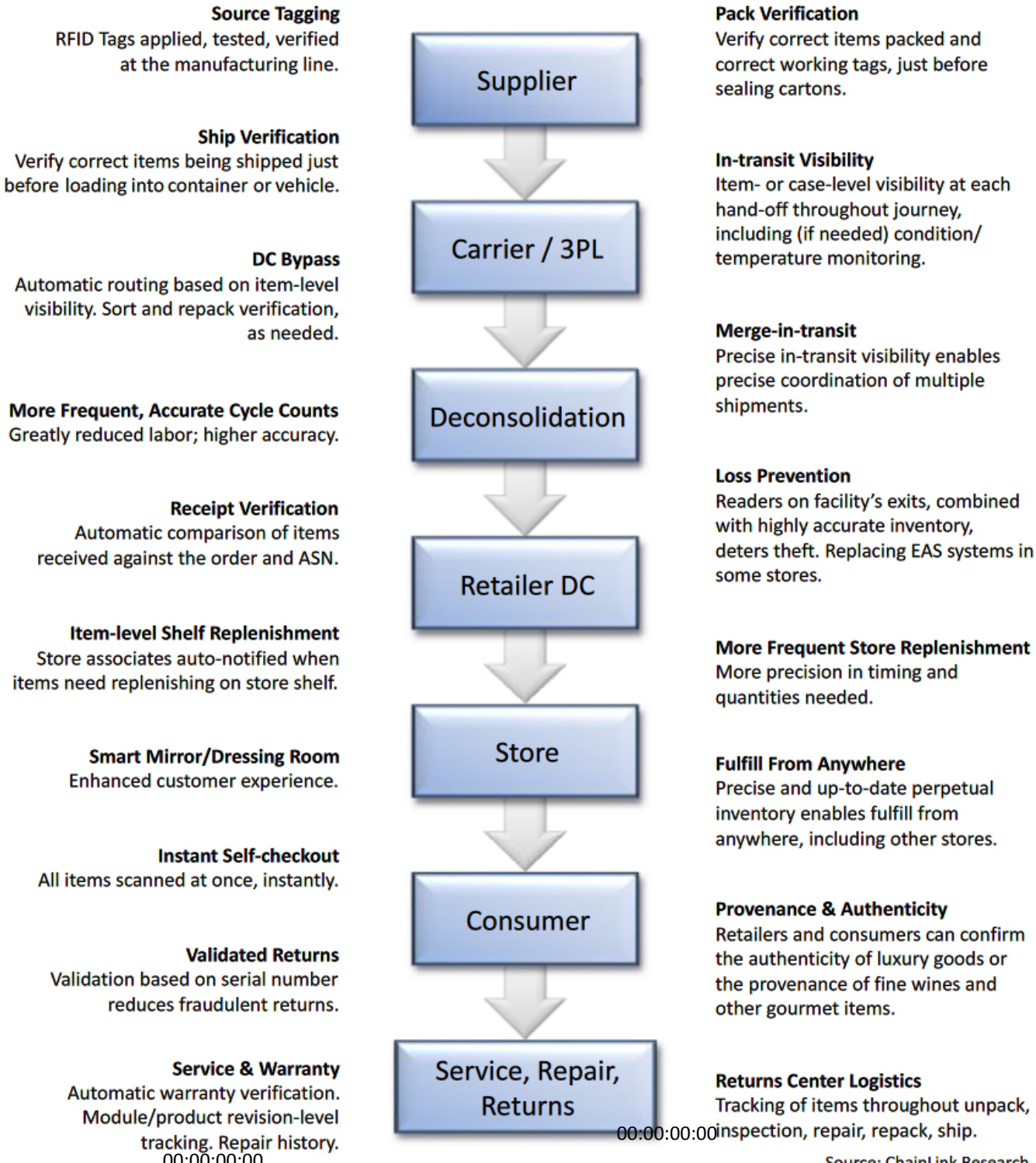

Figure 2 - End-to-End High-ROI Process Improvements Enabled by RFID

Figure 2 - End-to-End High-ROI Process Improvements Enabled by RFID

Thinking Globally (End-to-End), Acting Locally (Solving Specific Problems)

As shown in Figure 2 above, once items are being tagged at the source, there are many different places and ways within the retail supply chain that RFID can be used to improve performance or provide additional value to the consumer. Each retailer, working in conjunction with their suppliers and third party service providers, will need to decide where to focus investments and attention.

Even something as simple as reducing out-of-stocks (OOS) at the store can be addressed in several different ways by RFID. The causes of OOS are varied (see *Figure 3 at right*). With RFID, the frequency and accuracy of cycle counts in the store can be dramatically increased, thereby greatly improving perpetual inventory accuracy, which in turn improves store forecasts and ordering. Alternatively, RFID can be used to improve shelf replenishment by automatically alerting store associates to refill shelves. Or DC perpetual inventory counts can be greatly increased, not only by more frequent cycle counts, but also by receipt and shipment verification.

OOS Cause (U.S. average)	%
Store forecasting	18%
Store ordering	33%
Shelf replenishment (in the store, but not on the shelf)	22%
Distribution center	11%
Retail HQ or manufacturer cause	13%
Other	3%

Figure 3 - Causes of Out-of-Stocks

(Source: *RFID's Impact on Out of Stocks: A Sales Velocity Analysis*—Hardgrave, Waller, Miller)

US retailer's average out-of-stock rate is about 8%,[4] resulting in about 3.4% loss of revenue for retailers[5] and 2.6% loss of revenue for suppliers. RFID helps reduce OOS levels, resulting in increased sales. How much? One study[6] found that the use of case-level RFID in the back and front of the store reduced out-of-stocks by an average of 62% for fast moving goods (products selling 7-15 units per day per store) and 30% across all goods. Those improvements translate into a *1% increase in sales for retailers*. While case-level RFID in the store only focuses on improving shelf-replenishment (22% of OOS causes), item-level across the chain can additionally improve store ordering, DC, and manufacturing causes, potentially increasing the sales uplift to 2%-3%. A 2% sales uplift for a $15B retailer translates to *$300M in increased sales*, a great payback for simply addressing OOS issues across the supply chain using item-level RFID.

Besides decreasing OOS, RFID improves inventory accuracy and timeliness of replenishment decisions. This enables retailers to have *the right items* in stock more quickly—both reducing markdowns and increasing sales further. And there are countless other improvements RFID enables—better promotional effectiveness and uplift, increased store associates' time with customers, reduction in shrinkage, improved efficiencies and labor cost reductions across the supply chain, reduction in retailer-supplier disputes, reduction in warranty and returns fraud … the list is almost endless. Thus, regardless of the initial impetus and goals for an RFID implementation, it is in the retailer's interest to plan ahead and think about the longer-term goals and broader end-to-end potential, ensuring that the systems they put in place initially have the adaptability and scalability to ultimately support those longer-term, end-to-end improvements.

[4] Source: Corsten, D., and Gruen, T., "*Desperately Seeking Shelf Availability,*" International Journal of Retail & Distribution Management, 31 (11/12), 605-617.

[5] If an OOS results in the consumer buying a different brand at the same store, it is a loss of sale for the brand owner but not the retailer. If they buy the same product at a different store, it is a loss for the retailer but not the brand owner. If they don't buy anything it is a loss for both.

[6] Source: "*RFID's Impact on Out of Stocks: A Sales Velocity Analysis*"—Hardgrave, Waller, Miller

Retailers' Mandates—Impact on Suppliers and Supply Chain Performance

The Move to Source Tagging

In early pilots, retailers largely tagged items themselves at the store or in their DCs. This still happens in a few cases, such as Borsheims' tagging of jewelry at the store. But in the majority of cases, once a retailer goes beyond the pilot and into production, it is more cost-effective to have tags applied by the manufacturer at the source. Suppliers are being asked to apply the tag at the point of manufacturing and in some cases the logistics service providers are expected to provide item-level visibility of goods in motion throughout the supply chain. Hence, RFID-related requirements have been added to the vendor compliance manuals of many major retailers.

What do these new mandate requirements mean for suppliers? How are suppliers adapting? How can they realize benefits to offset the costs?

Piggybacking on Current Ticketing Processes—With a New Twist

Most retail suppliers already have substantial experience complying with various retailers' mandates, including very specific requirements for tagging and ticketing items. The new RFID mandates are, to a large extent, simply extensions of the current ticketing requirements. RFID may be integrated into the barcode label or tag or it may be an additional new hangtag or label. To avoid penalties/chargebacks resulting from the retailer receiving non-functioning RFID tags, suppliers need to test tags to verify they work—typically done in bulk mode (often by a service bureau) before the tags are applied. Diligent suppliers test again before shipping, to make sure there are 100% readable tags going into the carton.

Diligent suppliers avoid charge backs by testing RFID tags before and after packing, to make sure they are 100% readable and correct in the carton.

A Microscope on the Supplier

Some retailers find, as they start implementing item-level RFID, that the rate of supplier errors seems to rise suddenly. Of course suppliers aren't suddenly getting worse. Rather RFID exposes errors and lack of precision already existing on the supplier's side. RFID automates the receipt accuracy checking process for the retailer, comparing what was actually received against what was ordered and what was in the ASN. Once the supplier starts getting this feedback from the retailer, often within a month or two, many of those errors are reduced. The new process integrity helps expose and correct issues that were previously slipping through the cracks.

Reducing Disputes

RFID provides a level of electronic Proof of Delivery (e-POD) not previously attainable with barcodes—*automated* 100% verification of exactly what was received at the item level. Errors in the e-POD may occur when a tag malfunctions or cannot be read or an item was mistagged (e.g. wrong tag on the item, missing or duplicate tags on an item). This is another reason for suppliers to perform Pack Verification (see the *Pack Verification* section below).

Potential Benefits Can Offset Increasing Costs for Suppliers

It is in the interest of the supplier to make process improvements in order to realize benefits and ROI from their RFID investments.

RFID is not free for suppliers. Tags can add in the neighborhood of 10-30 cents per item shipped, depending on volumes, type of tag, and services provided by service bureau and/or label converter. In addition, there are one-time costs for readers and implementation costs such as retraining staff and IT integration (depending on what the supplier is trying to accomplish). The per-item cost can be hard to absorb for low-margin items. It is in the supplier's interest to try and get some benefits from these investments.

Potential Improvements to Supplier's Operations

If the supplier does the bare minimum to meet a mandate, then it is all cost and no benefit to the supplier (except, of course, the overarching benefit of keeping that business with the retailer). However, there are potential process improvements that suppliers could make. Some of the more immediate and obvious ones involve using RFID for pack verification, ship verification, and ASN generation.

Pack Verification

Errors are <u>much</u> cheaper to catch and correct at the supplier's packing and shipping operations than at the retailer's receiving operations.

Pack verification happens after a worker has packed a case or carton, usually just before sealing it. All of the RFID tags in the case are read and compared against the ship order. This read can happen automatically (if the packing station has a built-in reader) or by the worker using a handheld reader (less new infrastructure required, but more per-order labor required than the built-in reader). If everything matches, then the case is sealed. If there are discrepancies, then a worker manually investigates and fixes any issues. As mentioned above, the issue could be that the wrong items are in the carton, but it also could be that a tag is not working or an item is mistagged. All of those issues are *much* cheaper to catch at the supplier's shipping operations than at the retailer's receiving operations.

Ship Verification

Ship verification is similar, except that it happens as cartons are loaded onto the truck or onto a pallet and then again as pallets are loaded onto a truck. This confirms that the right items are being loaded into the right vehicle. This information can be fed to the system that will generate and send the ASN. This comes almost as close as possible to a 100% guarantee that the ASN will always match exactly what was shipped.

Integrating With Retailers' Systems

Chargebacks and penalties are reduced when there is strong integration between the suppliers' and retailers' systems. Combining pack and ship verification with automatic ASN generation helps assure that the data hierarchy within the supplier's system for item-to-carton-to-pallet-to-ASN are error-free and aligned. The supplier can then use this data in important ways to leverage EDI transaction data while keeping track of change orders from the retailer, assuring that all the documents and processes the supplier must adhere to are taken into account. Retailers provide specific guidance from the largest to the minutest requirements. Although it is a big task, the benefits of avoiding charge-backs, reducing order-to-shelf cycle times, and improved retailer relationships more than offset the cost of compliance vigilance.

Improving Supplier Inventory Management

As the use of RFID becomes more widespread at a supplier, there is also potential for RFID to be used earlier in the process. For example, if the tags are applied in manufacturing process, then they can be used during putaway of finished goods, during picking at the manufacturer's warehouse, and to enable more frequent and accurate inventory cycle counting in the manufacturer's finished goods warehouse.

Getting to Benefits for Suppliers

In spite of the potential benefits, it is hard to find suppliers that are currently doing more than simply meeting the minimum retailer requirements (adding the required RFID labels to their shipments). Partly this is because it takes time and investment to change processes and systems. As a larger and larger percentage of suppliers' outbound shipments are tagged with RFID, we expect it will reach a tipping point where some suppliers decide to implement those process changes and start reaping some of the rewards, so that RFID can become more than just an additional cost for them.

In fact, because of the benefits, a few manufacturers have decided to implement RFID without any mandate from their retail customers. One example is Rica Lewis, the top blue jean manufacturer in France. They do direct-store-delivery and manage the restocking at their retail customers' stores, which include Carrefour, Groupe Casino, and Auchan Group. Tags are applied at the manufacturing plant and then used to insure pack and ship verification at Rica Lewis' DC. At the store, the Rica Lewis sales person can now take a complete inventory within 10 minutes, instead of spending an hour or more scanning items. This gives the salesperson more time to interact with and sell to their retailer customer.

Maybe in the next couple of years, more than a decade after Walmart's original RFID announcements, other suppliers will follow the lead of progressive manufacturers like Rica Lewis and will begin to change their processes and actually turn RFID into a win-win for themselves and the retailers.

End-to-End RFID Implementation Examples in Retail

End-to-End RFID Implementation

One well known and highly respected high-end fashion retailer provides a good example of an end-to-end RFID implementation. They have more than 50 stores across Europe and North America, offering a wide assortment of high-end men's and women's fashion clothing. Their goals for RFID initially were to improve visibility and inventory accuracy within their DCs and stores, in order to make smarter and timelier store replenishment decisions. Based on the success of pilots run in early 2012, they decided to roll out RFID to all stores in the chain, tagging 100% of merchandise sold.

Tags are applied by their suppliers at the source. Products received at any of their distribution centers are read by a tunnel reader on the conveyor belt at the receiving operation. This automatically reads all of the items in all of the cases and compares it against the ASN sent by the supplier. If there are any discrepancies,[7] then the items are put aside for rework and investigation. They found that this alone improved their supplier quality levels tremendously. And it actually saved time in the receiving process since there was no need to read barcodes anymore.

This is a true multi-enterprise implementation. This high-end fashion retailer's distribution centers are run by two different 3PLs, each with their own warehouse management system (WMS). This required integration with their two different WMS systems (one of them proprietary), as well as the various ERP systems, suppliers, and their own store operations and other systems. Thus the ability to integrate across many different platforms, third parties, and trading partners was an important solution selection criterion for this fashion retailer's company.[8]

[7] First they will try to reread the case, just to make sure it wasn't an issue with an unread tag.

[8] After evaluating different solutions, they ultimately selected TAGSYS for their implementation.

The Role of the 3PL

The use of RFID in DCs represents an opportunity for 3PLs to differentiate themselves, based on their knowledge and ability to implement advanced practices on behalf of their client. Within the DC, this could include receipt verification, automated put-away, pick and pack verification, and ship verification. More broadly, 3PLs can use RFID to help implement DC Bypass, merge-in-transit, and other advanced logistics capabilities in a more granular and precise manner.

Port Logistics Group Example

Port Logistics Group (PLG) is a 3PL that runs distribution centers for some of the largest and most admired retailers and brand owners in the world. About 60% of their base is in apparel, footwear, and accessories. They have been involved in the transition to RFID for some of their key customers.

High Performance Receiving, Putaway, Packing, Cycle-counting

In one of their implementations, Port Logistics Group uses RFID for receive verification, using a cloud-based system from TAGSYS. Port Logistics Group plans further uses for RFID. One of their internet retailer customers demands quick turnaround. Most items need to be shipped out the same day they are received. Because each item has its own unique SKU, PLG currently has to remove each item from the carton and barcode scan it by hand. By converting to RFID, they will be able to scan the whole carton at once without even unpacking it, dramatically shortening receiving times and enabling better performance to shipment schedules.

They also see the potential to use RFID to automate putaway of hanging garments on their garment hang-sorter system.[9] One of the biggest opportunities is to improve cycle count of inventories. Currently Port Logistics Group does cycle counting of a portion of inventory every day, so that over several months they have counted everything in the warehouse. RFID will save them a significant amount of time in counting inventory, as well as increasing the accuracy.

Smoothing the Transition

Port Logistics Group found the changeover to RFID to be straightforward. They already provide client-specific processes, so implementing separate RFID processes alongside barcode-based operations for other clients was not difficult. Workers found the equipment and software to be easy to use. They are already used to putting items on the conveyor. Pack

[9] This is a type of automated storage and retrieval system specifically for hanging garments—sort of a sophisticated version of what you see in dry cleaners.

station tasks have become even simpler. They no longer have to barcode scan each item, but simply place items into the carton on the table-top RFID reader. Overall, there has not been much training required or disruption to processes. This is the sign of a well-designed and intuitive user interface, workflow, and overall system.

A Competitive Differentiator

Port Logistics Group believes their RFID capabilities will be a competitive differentiator. Their customers count on PLG to be retail logistics experts that intimately understand the latest technology and how it can be applied to meeting retailer's requirements. TAGSYS' expertise and the capabilities inherent in their platform went a long way towards helping PLG meet these customer expectations. PLG plans to stay ahead of significant RFID compliance requirements they see coming down the road from more and more of their retailer customers. Their experience is that RFID helps lower their labor and space costs, thereby improving margins. For Port Logistics Group, RFID is an increasingly important part of their expertise and service offering portfolio.

Selecting and Creating the Right Foundation

Reducing the Complexity: From Engineering Projects to Off-the-Shelf Systems

While RFID is simple in concept, it is complex in practical implementation. For this reason, the selection of an implementation partner and system provider is key. RFID is very different than your typical systems integration project. It requires a specialist and a solution that are up to the challenges of RF physics, matching the right tags to materials, setting up the physical environment of readers and network, protocol and integration challenges at all the different levels (from the over-the-air interface, to readers, to enterprise and inter-enterprise systems). If not managed, this complexity can ruin a project. Therefore, selecting a system integrator with in-depth RFID experience is a must (but they are unfortunately still not so common).

It also is critical to select the right system; one that is designed and integrated to work together all the way from the tags and readers, to the middleware, applications, management tools, and analytics. Some systems have been designed from the ground up with all the components to work together for a specific application environment (such as DC and store processes), providing all of the elements from tags, to readers, to software that integrates with existing enterprise systems. Those integrated, tried-and-true approaches can greatly simplify the complexity for the system integrator and the end customer (See below Figure 4 – *A Comprehensive Integrated Platform Mitigates Complexity*).

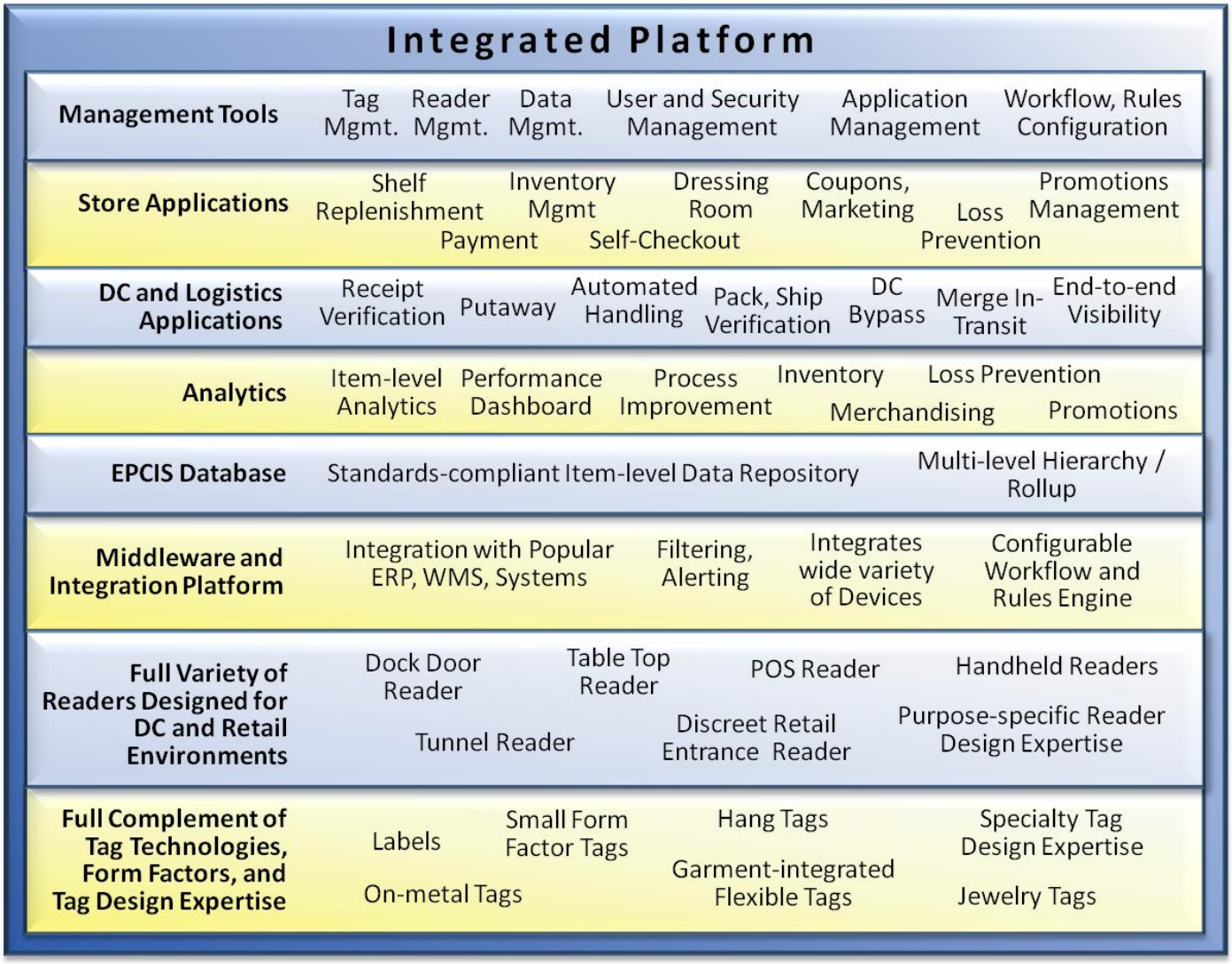

Figure 4 – A Comprehensive Integrated Platform Mitigates Complexity

It is also important that the system supports straightforward integration of trading partners and their systems, to achieve the end-to-end potential benefits mentioned earlier. If it is not easy, low-risk, and cost-effective for suppliers and third parties to implement, they will resist efforts by the retailer to mandate RFID implementation.

Adaptable Solutions

Though there are common processes within the retail industry (for example receiving at a DC), differentiation is still a must for the success of each retailer—delivering a unique experience to their customers, and configuring their unique supply chain for optimum performance. As mentioned above, each retailer will choose a different starting point, set of products, and set of processes for RFID. Therefore, solutions must be easily configurable to meet the unique needs of each retailer. When a lot of custom coding is required, it slows implementations, impedes getting to those advanced process improvements, increases project costs, and makes maintenance and system evolution more costly.

In addition, the solution needs flexibility to encompass different trading partners' requirements. A large retailer may be able to mandate that all suppliers use tags with a specific encoding, such as SGTIN-96. However, a supplier may have different needs than the retailer and/or for economies of scale may desire to standardize on another type of encoding for all their tags (such as using SGTIN-198 instead of SGTIN-96). The solution should be able to easily accommodate that. Another example, if one of the retailer's 3PL's is using their own proprietary WMS and it is prohibitively expensive for the RFID solution to be modified to interface to that 3PL's WMS, that prevents the retailer from realizing a complete solution encompassing all of their trading partners. A solution that is flexible enough to accommodate the varying needs of the players across the chain can enable supplier's benefits, making it easier to achieve compliance, and facilitates true end-to-end integration incorporating all trading partners and service providers.

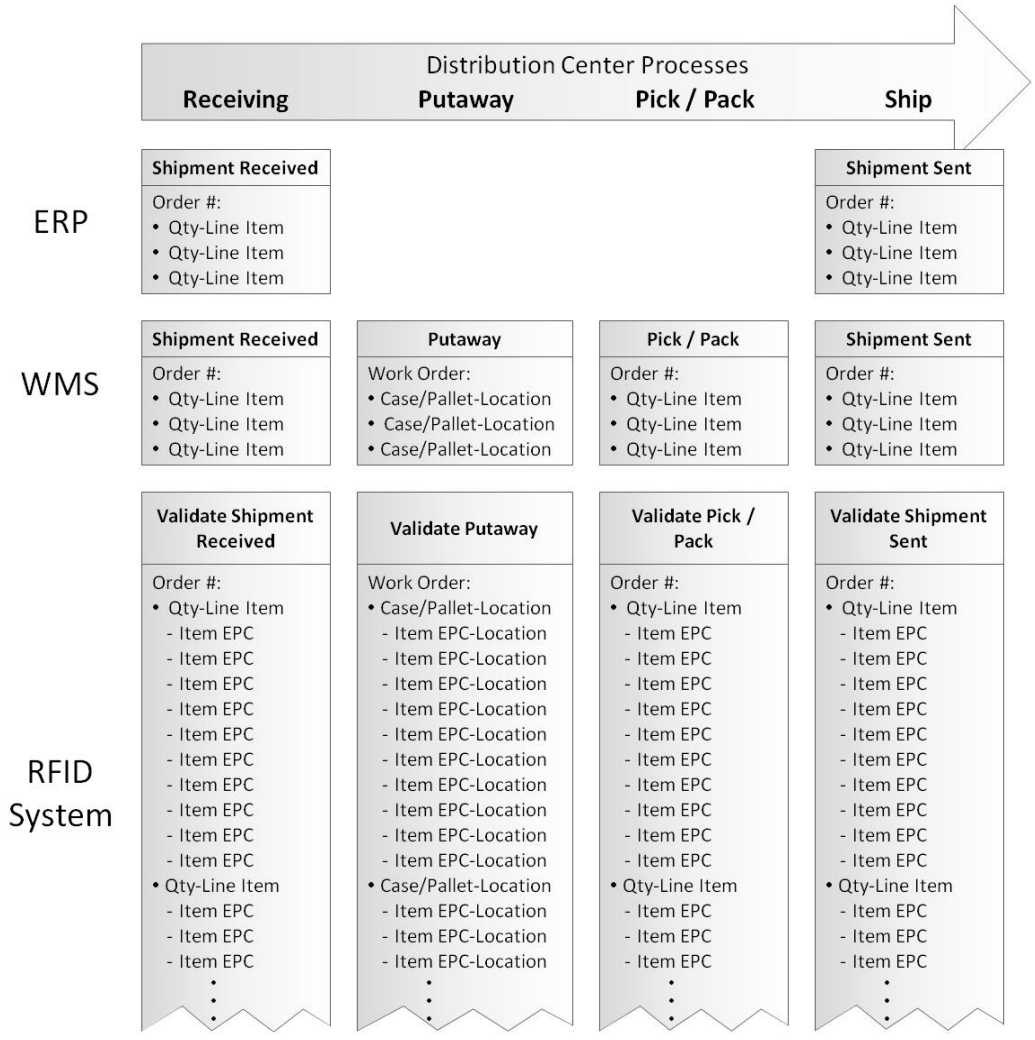

Figure 5 - Item-level Data (RFID) vs. Transaction-level Data (WMS, ERP)

Little RFID Tags = Big Data—A New Breed of Applications Emerges

It is important to consider how much data is generated and how that data will be used to make improvements and add value. RFID creates new possibilities and processes such as real time inventory and item-level process validation. As a result, a much larger volume of data is generated, and it is item level data

rather than transactional data (see Figure 5 above). When a major retailer implements RFID on a significant portion of their products, the result can be literally billions of additional data points. Most existing enterprise systems were designed to handle transaction-level data (like a P.O. or shipment) and not designed to handle this volume or level of detailed item-level data.

Retailers cannot be expected to re-architect their existing systems to take advantage of this new data. What is needed is a new breed of application designed specifically to handle item-level RFID data, while integrating to existing legacy systems and processes. The new systems should be able to:

- Translate item-level data into transaction-level data that existing systems can absorb.
- Filter and consolidate item-level data into meaningful business events, making efficient use of network bandwidth.
- Provide management-by-exception via rules-based monitoring of these enormous new data flows.
- Store item-level data in an EPICS-compliant database, organized in a hierarchical manner (i.e. consolidating local event data up to higher levels business event data as needed).
- Provide business intelligence and analytic tools designed specifically to leverage this granular item-level data.

Architecture Matters—Advantages of a Distributed Approach

RFID is by nature a distributed technology—the readers have to be physically situated out in the various locations across the supply chain, in relative proximity to the tags/objects being read. At the same time, the retailer needs to integrate the RFID data from this dispersed network of readers into central systems, at least for transaction processing and analytics. They also need to integrate with other distributed systems such as store-level and DC-level integration, as well as with trading partners' systems.

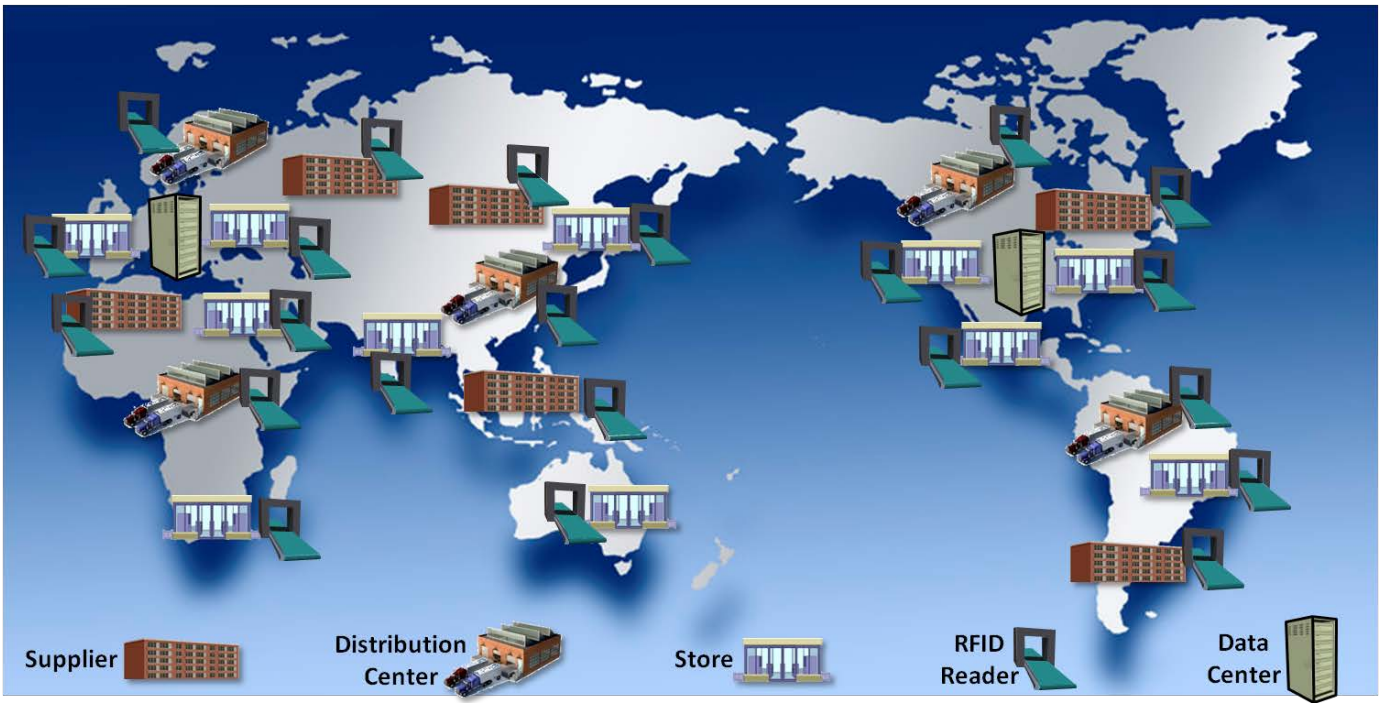

Figure 6 – A Retailer's RFID Infrastructure is Inherently Distributed

Because of this, the following characteristics are critical in any solution:

- High availability / nonstop operation – if a network connection or the central server goes down, the DC and store must continue to operate.
- Scalability – the solution should be able to scale as stores are added, to support any size retailers, even with thousands of locations (stores and DCs).
- Low Latency – with modern high speed handling equipment, often the system needs to respond within milliseconds.
- Multi-level integration – the ability to easily integrate at different levels with different systems.

While there are different ways to achieve these goals, a distributed architecture provides these capabilities naturally. A good example is the TAGSYS system mentioned earlier. It is built on a distributed architecture foundation and provides many of the attributes needed for successful end-to-end implementations.

Conclusion

Retail powerhouses like Walmart and Macy's have paved the way for others to follow with major RFID rollouts. But RFID is not just for the largest retailers. It is now being implemented by mid-size retailer and international brand companies in almost all retail sectors including apparel, footwear, health and beauty, consumer electronics, jewelry, and others. As suppliers get on board and start tagging for other retailers, it will lower the burden of compliance. However, for retailers with limited IT resources, it becomes critical to select the right solution, one that reduces the cost and complexity of implementation while still providing the adaptability to the retailer's unique processes. Having the right knowledge, a clearly articulated vision of what you are trying to accomplish, well-specified requirements, and the right implementation and solution provider partners are critical ingredients to success.

The revolution is here. Retailers are innovating and consumers are noticing. Mobile shopping, omni-channel integration, personalization, store associate empowerment … there are so many changes happening at the same time right now. Retailers need to transform or risk getting left behind. RFID, providing end-to-end item-level visibility and capabilities, is a key foundational element of this transformation. And it's ready now. For those who seize the opportunities now that RFID makes possible, the sky's the limit.

Appendix A: Criteria for Selecting a Solution

Selecting the right solution greatly increases the chances for a successful outcome. Below are a number of criteria to consider when selecting a solution. These may be useful for structuring your selection process and/or as input to an RFI, RFP, or RFQ.[10]

Criteria	Description
Understanding of Your Business	The solution provider should not be just a technology company, but also be able to understand your business—your operations, processes, constraints, and expenses. They should truly understand your objectives, requirements, and working environment, so that the final system meets your needs. You should ask how they would address specific problems or constraints in your business, to gauge their level of understanding.
Extendible Platform with 'Forward-compatible' Customizability	Systems built as one-off customized solutions should be avoided. Instead, look for a platform approach with forward-compatible configuration and customization. The architecture should guarantee that any customizations that are built according to the solution provider's specific guidelines will continue to work on all future upgrades to the platform. This ensures that you can leverage future advances and investments made by the solution provider in improving their system. Find out from the provider how your specific customizations (if any) can be built and how they will guarantee forward-compatibility with future releases.
Track Record and Stability	It is best to go with a solution provider with depth of experience and that has 'seen it all.' You don't want to be the guinea pig they learn on. Some questions to ask a provider: • How many RFID implementations have you done overall? How many in retail? • What types of settings and environments have you dealt with? What use cases? • How many tags, readers, and sites have you built and deployed in total? • Who are your RFID customers? Who is referenceable? Due diligence about the financial health and viability of the vendor is strongly advised, to ensure their longevity to support you in the long run.
Completeness and Internal Integration	It is desirable to have a system that includes all of the pieces, well-integrated together: tags, readers, middleware, application, analytics, and management infrastructure. A technically knowledgeable individual, representing the interests of your firm, should evaluate how well integrated these pieces actually are. Avoid cobbling together multiple technologies from multiple providers. Besides reducing integration headaches, having a single provider creates a single point of accountability for solving problems.

[10] Request-for-Information, Request-for-Proposal, or Request-for-Quote

Criteria	Description
Adaptability	The solution should be adaptable to the unique and specific needs of the retailer and trading partners. Some specific questions to explore: • What effort is required to customize the solution for your intended use cases and processes? • How can the system support needs of different trading partners, such as different tag data formats, tag placements, different levels of supplier technical sophistication and systems, proprietary legacy systems, etc? • 'What-if' questions for handling changing requirements. This dialog should be very specific about the processes and uses cases you intend to implement—now and potentially in the future. For example, you may be looking at doing receive verification in the DC, or cycle-counting in the store, or store shelf replenishment, or loss prevention, or self-checkout. How has the solution supported those specific processes at other retailers?
Integration with Other Systems and Entities	It is important that the solution integrates relatively easily with existing external systems. Some questions to explore with the solution provider: • How does the solution integrate with the specific applications you already have in your portfolio? The specific system of interest will depend on the use cases you intend to implement, and may include systems such as your ERP, WMS, Inventory Management, POS, or Store Execution systems. Ideally, the solution is handling and digesting all of the item-level information into a form easily assimilated by your existing enterprise systems and processes. • How will your existing service partners (e.g. 3PLs) and suppliers systems be integrated? • In the future, whether due to M&A or other reasons, there will likely be new systems that need to be integrated, beyond your existing known systems. You don't want to be locked into just a specific set of currently supported integrations. What are the solution's overall integration capabilities, approach, and platform?
Item-Level Data Handling	The system should be designed to efficiently deal with RFID idem-level data. Capabilities that should be addressed: • How is item-level data translated into meaningful business events and decisions? • What sort of rule-based engine is there for filtering and consolidating/rolling up item level data and for configuring and generating alerts (management-by-exception)? • How much network bandwidth is required for the scenarios you plan to implement? • Does the system provide an EPICS-compliant database? What are its capabilities?

Criteria	Description
Scalability	Scalability should be considered at multiple levels: • Can the readers support the speed of conveyors and volumes of item-level reads expected at your DCs and any other high-volume operations? • Can it absorb, filter, translate, and analyze the overall volumes of data across all of your sites and network? • Does it effectively filter, summarize, and encapsulate the raw reader data to make efficient use of available network bandwidth? Scalability should be evaluated by knowledgeable technical individuals looking at the vendor's architecture and performance claims, but certainly validated by real-life customer examples and your own independent testing as well.
Availability	Requirements are based on the level of down-time an operation can tolerate and the cost. Some questions to explore about the solution: • Can stores and DCs continue to operate when the network or central server is down? • What failover time guarantees does the solution provider support? Will the agreement with the vendor include SLAs (with penalties for non-compliance) for failover time? • How often do they test failover? Restoration of backup data? • Can they provide actual customer incidents and references for fault-tolerance claims? • Who is providing the actual hosting and system management?
Reliability	Look for a solution provider that offers reliability guarantees, such as read rate guarantees. Firms may claim in the range of 99% up to 99.999% read rates. It is important that any guarantee refers to actual observed performance in your production setting, rather than the number of tags that are readable under ideal conditions. Guarantees should be backed up by a service level agreement with 'teeth' (i.e. consequences for non-performance).
Latency	Latency requirements will depend on the nature of the processes you want to automate and what equipment is involved. For example, diversion decisions on a high-speed conveyor may need to be made within milliseconds after a case passes by the RFID reader. Here you need to be quite specific, again validating the vendor's claims with references and your own testing.

Criteria	Description
Challenging Materials and Environments	RFID is sensitive to metal, liquids, different materials with different impedance, and RF interference. Solutions vary dramatically in how well they perform on different products and in different challenging environments (e.g. with high levels of RFI[11] or a lot of metal shelving). It is critical to specify and *validate* performance with your specific products and environment. A solution provider that has a proven track record working with challenging materials and environments will give you the flexibility as you may want to tag different products our encounter different challenging environments in the future.
Aesthetics	Aesthetics is a key consideration in selecting a solution (both tags and readers) for many retail environments. Big clunky ruggedized readers that are appropriate for a warehouse or dock doors make no sense in a high-end fashion retail environment. Readers that can discreetly integrate into the environment, without requiring expensive customization, may be required. The tag may present even more challenges. When tagging fashion items, lingerie, jewelry, and shoes for example, the traditional hang tag may not fit with the brand image and aesthetic. In this case, tags should be much more discreet, perhaps even woven or integrated into the product itself.
Environment-specific Performance	It is one thing for tags to perform in a lab. The ultimate performance test is in the context of the retailer's own facilities, products, workflows/processes, and applications/infrastructure. Thus requirements, testing, and pilots should be done within the messy real-world environment.
Business Intelligence / Analytics	The solution should provide analytics designed specifically to ingest item-level RFID data. Find out what the system can do with the specific RFID data you will generate. A highly configurable central dashboard, customizable queries and reports, and a relevant library of prebuilt retail analytics are desirable.
Innovation and IP	You don't want a solution provider that is standing still, under-investing in their technology. Or one that is vulnerable to intellectual property litigation. It is good to ask about the size of their ongoing R&D investment, as well as their patent portfolio.

[11] Radio Frequency Interference

719 Washington St., Suite 144

Newton, MA 02458

617-762-4040

Email: info@CLResearch.com

Web: www.clresearch.com