RFID for Loss Prevention
Planning Guide

Sensormatic
by **Johnson Controls**

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Adoption of RFID for Loss Prevention in Retail

Executive summary

The adoption of Radio Frequency Identification (RFID) for Loss Prevention (LP) in retail continues to evolve and advance. This guide is for professionals in loss prevention, technology, and store operations to help you better understand how to leverage RFID for your LP efforts. In this paper, we outline the key decision areas for you to consider when planning RFID for LP deployment:

- **Adoption Path:** LP vs. inventory-first and RFID as Electronic Article Surveillance (EAS) vs. Shrink Visibility

- **Assessing Readers and Tags:** Considerations in hardware selection

- **Selecting Merchandise Categories:** Factors to consider when deciding which categories of merchandise to protect with RFID

- **POS Integrations:** When and what type of integration is required

- **Estimating ROI:** Research-based approach to estimating the expected ROI

- **Planning Checklist:** Summary of implementation decisions and steps

Many apparel and footwear retailers have embraced RFID for item-level tagging[1]. The primary use case is inventory management, where RFID improves inventory accuracy and results in fewer out-of-stocks, an uplift in sales, and reduced markdowns. LP is one of the other main use cases that retailers have considered for RFID. We created this planning guide to provide a comprehensive perspective across critical elements to any system, how they integrate into your store operations and the outcomes you have available to you with an analytics reporting platform.

[1] In 2018, about ten billion retail items were tagged globally (Source: ChainLink Research).

RFID as EAS vs. Shrink Visibility (EPC as EAS)

There are two different ways that RFID can be used for LP: 1) RFID as EAS and 2) Shrink Visibility. RFID as EAS, as the name implies, is simply replacing a standard EAS tag or label with an RFID tag (or dual EAS/RFID tag), without item-level identification[2].

In contrast, Shrink Visibility (EPC[3] as EAS) uses the item-level identification capabilities of RFID (based on EPC) to provide visibility into exactly what items are being stolen, how many, when, and from where.

RFID as EAS		Shrink Visibility (EPC-based EAS)
Beep at door (EAS function)		Beep at door (EAS function) + EPC item level identification
No unique or specific item identification association		EPC association required for commissioning tags
Typically does not require software integration		Requires software integration into retailer ERP system
EAS hard tags are removed at POS, can be recycled if using source tagging program		EAS hard tags are removed at POS, can be recycled if using source tagging program
Non-EAS tags (those not removed at POS) require system integration so RFD-EAS exit system knows if merchandise passing thru is valid or not	VS	Non-EAS tags (those not removed at POS) require system integration so RFD-EAS exit system knows if merchandise passing thru is valid or not
EPC level item identification not used		EPC level item details used for Shrink Visibility analytics
Systems used at any shopper, employee or receiving exit/entrance		RFID readers may be used at other locations concurrently, besides exits to gain additional item level visibility
Can be implemented independent or part of an inventory management solution.		EPC codes from RFID readers retained for LP and inventory analytics and reporting
		Usually an extension of inventory management

Figure 1

RFID as EAS is a simple concept, essentially using RFID to achieve conventional EAS benefits. This alerts the store staff that something is being stolen (beep at the door) but provides no information about what is being stolen. In contrast, Shrink Visibility (EPC as EAS) provides EPC item-level identification about exactly which items are being stolen in addition to the beep at the door. In order for a Shrink Visibility system to provide this item-level identification, each RFID-tag must be associated with the specific item it is being attached to by the EPC.

This difference between the two approaches has implications for

the tag commissioning system as well as business intelligence analytics opportunities. Shrink Visibility requires the tag commissioning system to read item-specific data (such as SKU, size, color, etc.) from the retailer's product database and associate the unique ID of the tag with that specific physical item[4]. This EPC-to-item association is then stored for later use throughout the item's journey. In contrast, that association is not needed when using RFID as EAS. In this case, the tag is

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[2] Each tag still has a unique code (the EPC code), but with RFID as EAS, the retailer is not using that unique code to identify the item.
[3] EPC = Electronic Product Code, a GS1 standard for RFID tags that enables every tag to have a globally unique identifier.

[4] These codes are unique per-instance of the item; that is if there is a case of 100 identical items, each of them will have their own unique EPC code.
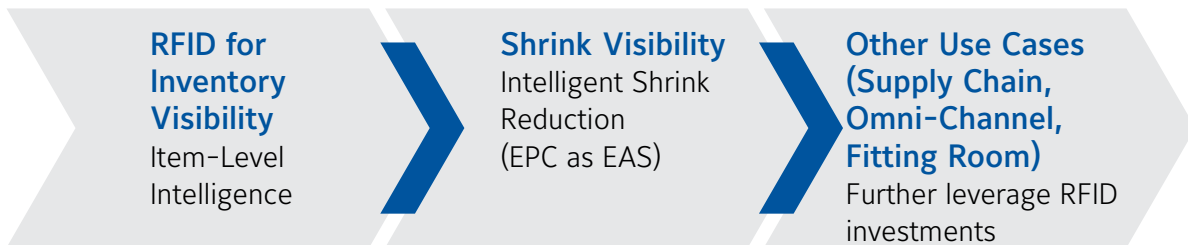
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just being used as if it were a simple EAS tag to alert the staff when an unpaid item passes through the detection zone of an RFID-EAS exit system and leaves the store. Therefore, the RFID as EAS system only needs to ensure that each tag contains a unique ID with the right EPC Manager Number[5]. Other differences between RFID as EAS and Shrink Visibility include:

- **Software:** Shrink Visibility (EPC as EAS) requires software (such as TrueVUE) integration into a retailer's ERP system. RFID as EAS does not.

- **EPC Retention and Lookup:** Shrink Visibility retains EPC and loss event-related data (such as video, time and location) to provide analytics and insights later about what items were stolen using EPC. RFID as EAS does not use EPC values and is not able to provide EPC-level details when analyzing loss events.

- **Reader Locations:** With RFID as EAS, readers are typically located at customer, employee or receiving exits[6]. With Shrink Visibility, readers are located at the customer exits (as with RFID as EAS), but may be located at other locations across the store to capture inventory management use case data as well. These other locations may include fitting rooms, receiving doors, employee exits, and transition points from a stock room to the sales floor.

RFID for LP Adoption Paths

The primary RFID use cases across retail are for inventory, but many are piloting and deploying for LP use cases. The key use cases include inventory management, supply chain, unified commerce fulfillment, and customer experience. There are generally two different paths to adoption for RFID for LP: Inventory First, or LP First.

Inventory First

| RFID for Inventory Visibility — Item-Level Intelligence | Shrink Visibility — Intelligent Shrink Reduction (EPC as EAS) | Other Use Cases (Supply Chain, Omni-Channel, Fitting Room) — Further leverage RFID investments |

Loss Prevention First

| RFID as EAS — RFID-based EAS | Shrink Visibility — Intelligent Shrink Reduction (EPC as EAS) | RFID For Inventory Visibility — Item-Level Intelligence |
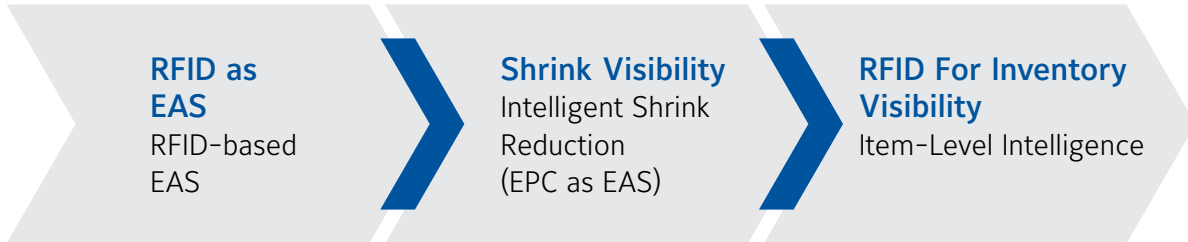
Figure 2

[5] The EPC Manager ID or EPC Manager Number is assigned by EPCglobal to indicate which company or entity this tag belongs to. Typically, each retailer would have their own EPC Manager Number(s) to distinguish their RFID tags from others. The door alarm system needs to check this, to not have false alarms when another an RFID tag from another retail chain is brought through the door. For more details on EPC Manager Numbers, see Section 5 (page 3) of EPC Global guide by GS1 US.
[6] Readers may be located at employee exits and/or receiving/dock doors as well.

Inventory First

The vast majority of retailers implementing RFID start with inventory visibility. This usually includes merchandise categories that benefit from RFID technology such as apparel, fashion accessories and footwear. From there, they can start using RFID for Shrink Visibility and other secondary use cases. In the inventory-first path, RFID is used to improve inventory accuracy, thereby dramatically increasing on-shelf availability and reducing out-of-stocks, resulting in increased sales. Sales uplift typically averages about 6%-10%. For seasonal and fashion items, improved inventory accuracy leads to more effective mark-downs, with similarly large financial benefits. Therefore, the use of RFID for inventory management has an extremely compelling ROI, particularly for high mix-complexity categories (with lots of size/color/style variants) with sufficient margins. Those characteristics are common in apparel and footwear.

According to a survey of 120 retailers by ChainLink Research, the top reason for implementing RFID (by a wide margin) is to improve inventory accuracy. This makes sense, since improved inventory accuracy is central to driving sales uplift and many of the other benefits and goals for RFID. Let's break down how this works: RFID enables cycle counting to be done about 25 times faster than traditional manual barcode scanning. Frequent, accurate cycle counting improves inventory accuracy, typically by 20% – 30%, allowing most retailers to achieve 95%-98+% store-SKU inventory accuracy[7]. This enables replenishment

"The business case for expanding our RFID implementation to more stores and departments has been driven almost entirely by one key objective: identifying and correcting inaccurate inventory in the system. This is especially critical when the system believes there is stock in the store, but in fact none is there. That inventory will not be replenished, sometimes for weeks or months, during which time sales opportunities are missed. We have measured sales improvements in every category we have used RFID. The best improvements have been where we have size and style complexity, such as footwear."

RFID Program Lead for a Major Multinational Retailer

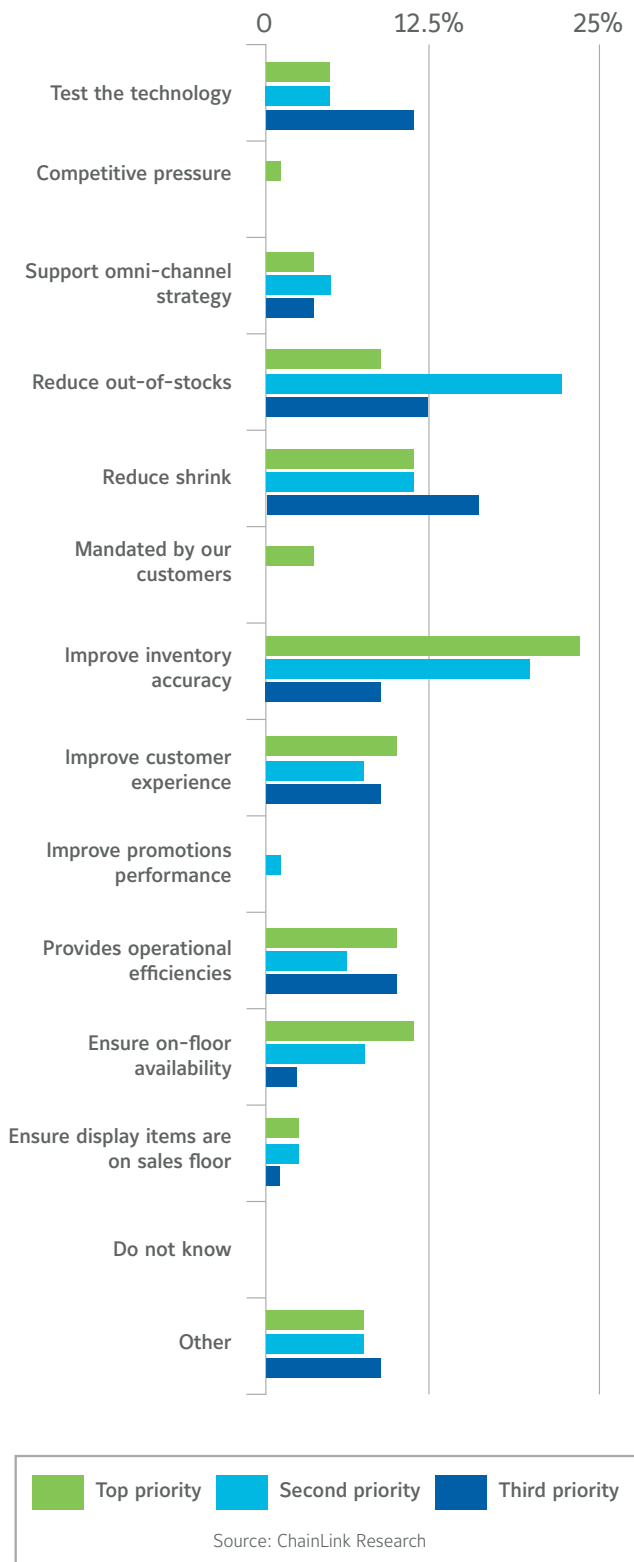## What were your top three reasons for implementing RFID?

Figure 3

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alerts to be reliably generated, increasing on-floor availability and decreasing out-of-stocks typically by 15%-30%. This in turn results in sales uplift in the range of 1% to 10% or more for those categories. For fashion or seasonal categories, the increased inventory accuracy allows for more effective markdown optimization, resulting in increased margins and sales.

The resulting increase in sales and profit is the fundamental core financial driver of most RFID implementations in retail and illustrates the central importance of improving inventory accuracy and reducing out-of-stocks (OOS). The dominance of this particular driver for RFID implementations is even more pronounced when you consider that three of the answers to our questions, in Figure 3 are just different aspects of the same core driver: inventory accuracy, OOS, and increased on-floor availability. When added together, these encompass the prime reason retailers implement RFID.

Once retailers have invested in the RFID infrastructure (tags, readers, software) required for inventory management, many start to examine secondary use cases to extract additional value out of their investment. These include supply chain, loss prevention, unified commerce fulfillment, and customer experience. If they decide loss prevention is the next step, Shrink Visibility (EPC based EAS) is their best choice since they have already made investments required for EPC-item level association.

Different Uses of Shrink Visibility Data

Shrink Visibility provides a wealth of data not available from conventional EAS systems (neither RFID as EAS , RF or AM technologies). Retailers are taking a diverse set of approaches to what they do with that data. Before embarking on a pilot, retailers need to figure out how they want to use the RFID data, analytics, and insights enabled by Shrink Visibility. Are you targeting entire categories or only specific high-theft products? Will you make changes to merchandizing or add personnel to troubled areas? Will you want to integrate video technology? How will you respond to the data you collect? How the data will be used is a key driver in deciding which items to tag, where to put readers and antennas, what kind of integration with other systems are needed, and what actions will be taken based on the new intelligence. Below we explore some examples.

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[7] US retailers have on average 60%-70% store-SKU inventory accuracy. I.e., the perpetual inventory number in the system will be incorrect for about 1/3 of items in a store. European retailers are only slightly better, on average in the low-70%.

Shrink Visibility Across the Store

With TrueVue and RFID systems (tags, video cameras, readers and antennas) strategically placed throughout the store, a more complete and detailed view of what is going on across the store is possible.

Examples of places readers may be located include customer entrance/exit, point of sale (POS) stations, employee exits, receiving doors, back-to-front store transition points, fitting rooms, and overhead readers in key departments. Hand-held readers are used throughout the store for rapid and frequent cycle counting and restocking. Combination detacher/readers can be used at the POS. With visibility across the store, a more comprehensive approach to loss prevention is possible to reduce internal and external theft.

STOREFRONT VISIBILITY

Improved shrink intelligence at all exits, with reporting and analytics.

Retailer Value
- Understand quantity, what and when losses occur
- Unique EAS alarm capabilities
- EPC-level insights into loss events

ON-FLOOR VISIBILITY

Visibility to RFID tagged item availability and zones across the store.

Retailer Value
- Reduce shrink in high-theft problem zones such as fitting rooms

TRANSACTION VISIBILITY

Tracking of items sold, disposition at POS. RFID tag read and detach capability.

Retailer Value
- Combat sweethearting
- Return fraud identification
- Reduced internal theft

RECEIVING VISIBILITY

Leverage RFID fixed infrastructure at shipping and receiving areas of the store.

Retailer Value
- Identification of vendor shortages
- ASN reconciliation
- Missed-ship identification

SHRINK VISIBILITY across the store

Figure 4

Combating Internal Theft

Employees know store LP systems and may figure out ways to defeat them without getting caught. They have access to detachers and/or can learn where disposable RFID tags are installed and how to remove them. To combat this, the retailer can install RFID readers at all the entrances and exits (front and back of store). If RFID is used to receive goods in the back of the store, then the retailer can get an accurate record of all items entering the store, including exact quantities. By combining this with POS and storefront theft data, the retailer can identify imbalances and anomalies that can alert them to potential internal theft. Further, RFID visibility at POS can help deter sweethearting (cashier-enabled theft) where tags are unable to be removed from merchandise without a legitimate purchase. RFID-enabled receiving at the store also helps detect when incorrect items or quantities have been sent from a supplier or the DC[8].

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[8] RFID-based pick, pack, and ship at the DC helps reduce those errors before they happen. RFID-based receiving at the DC can enable ASN reconciliation and help detect vendor errors.

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Dynamic Alarms, Adaptive Prevention Tactics

Shrink visibility enables a more dynamic approach to loss prevention. Retailers can differentiate alarms based on merchandise value and quantity of items stolen—a subtler alarm for modest value thefts and a more urgent alarm for major thefts such as those from Organized Retail Crime (ORC) units.

Shrink Visibility can also enable more adaptive prevention tactics. Organized criminals are creative and opportunistic. They are constantly learning what protective measures retailers are adopting and they adapt. With Shrink Visibility, retailers can more quickly sense new patterns or tactics in theft and more dynamically and responsively adjust their LP approaches.

Dynamic Inventory Replenishment

With Shrink Visibility, when a theft occurs, perpetual inventory counts can be adjusted to accurately reflect the actual inventory level, triggering replenishments and reorders as needed. Store personnel can then replenish the stolen items in a timely manner, reducing out-of-stocks and lost sales.

Stop Fitting Rooms from Being Theft Staging Areas

Several retailers have piloted readers in their fitting rooms. However, few have gone much beyond this phase. Below we discuss some of the considerations, but first let's understand the potential uses. RFID-enabled fitting rooms provide real-time data on shoppers and their interaction with merchandise. This visibility allows retailers to better understand their customers and influence buying decisions in the store's most important conversion zone. Using RFID technology, retailers can capitalize on the opportunities presented in the fitting room, empowering sales associates with insight into customer preferences and service needs to drive conversion. Smart fitting rooms can deliver data insights to drive merchandising decisions, a better customer experience, and a corresponding increase in sales.

Regarding loss prevention, with RFID-enabled fitting rooms, retailers will be able to see when someone is using the fitting room as a staging area for an imminent theft by observing what kind of items are being taken into the fitting room together. They should be able to correlate the specific items being stolen (including which exit they are going out) with where the items are being staged. Armed with this knowledge, retailers may

prevent an imminent theft and/or take measures to prevent future thefts.

Fraudulent Returns

Once Shrink Visibility is deployed, there are advanced loss prevention use cases that can be leveraged. Some ORC groups take advantage of generous retailer return policies, stealing from one store and returning the items at another, all within relative proximity. Some loss prevention teams suspect such activities, but don't have the tools or data to confirm their suspicions, even if the specific store and specific SKUs stolen have been identified. With Shrink Visibility, retailers use RFID tags on the suspected targeted items and install RFID as EAS systems at exits. Now they can see the items being stolen (not just SKUs, but individual items since each item has a unique EPC). In addition, they can put RFID readers at the returns desk of surrounding stores to know when and where stolen items are returned. With this data and insight, retailers will be equipped to stop theft before it happens.

Tackling ORC Operations

Shrink Visibility can go beyond identifying, down to the item level, what has been stolen. It can also enable effective, targeted actions for loss prevention teams, which is why many retailers have deployed video surveillance. With Shrink Visibility they can integrate that video into their RFID (EPC as EAS) systems to build stronger forensic evidence. When someone goes out an RFID protected exit and triggers an alarm, the system can read the RFID data and connect the EPC to video of the event at that exact moment. They can then correlate a specific face with a specific theft. This is only possible with EPC as EAS. Retailers can subsequently use facial recognition to identify repeat offenders and alert the security staff the next time that person enters the store.

With RFID, a retailer has a database of exactly what items have been stolen (which SKUs and which instances). Another proactive LP tool that only EPC as EAS can enable is monitoring stolen goods markets. LP personnel can visit venues suspected of selling stolen goods, such as particular pawn shops, flea markets, and street hawkers. By using an RFID hand-held reader Geiger functionality, they are able to identify the stolen items by reading EPC-enabled RFID tags, alerting law enforcement, and shutting down fencing operations to further reduce shrink.

Markdown Reduction

When fashion or seasonal items are stolen, the system will show more items than are actually present. The retailer will thereby markdown the items more heavily than they would if they had an accurate count. This causes a loss in profit on the remaining items, above and beyond the loss from the original theft. With Shrink Visibility, the inventory count is updated to reflect the true number of items left, and thereby the retailer can implement less aggressive (more profitable) markdown.

Loss Prevention First

When retailers implement RFID for LP before implementing RFID for inventory management, they are almost always implementing RFID as EAS. This is usually due to the desire for EAS functionality in locations or scenarios where the constraints don't allow conventional EAS (neither RF nor AM systems). Business leaders who chose to lead RFID introduction with a LP use case knew the migration path for inventory use cases would be easier for store operations when the time was right.

Use Primarily Driven by Store Aesthetics and Design Requirements

A growing number of retailers are using RFID as EAS, i.e. using RFID as a simple EAS system. Most, if not all of them, made this choice driven by store aesthetic desires or operational requirements. To maintain the desired shopping experience or store design, some retailers or malls don't allow pedestals to be installed while others do not want to or can't go through the complexities that go along with excavating the floor. In these situations, a ceiling-mounted RFID-based EAS system may be the only viable option. In some cases, the retailer continues to use standard EAS pedestals in the stores where they are allowed and uses ceiling-mounted RFID wherever the pedestals are not allowed.

Normally retailers who intend to use RFID for inventory management will implement that first, before moving on to LP or other use cases. However, there are early adopters who intend to use RFID for inventory management but are starting first with RFID as EAS for LP, usually because the LP team is leading the initiative.

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Assessing Antennas, Readers and Tags

Reader Considerations

When doing RFID as EAS, a retailer may choose to put antennas and readers only at the customer entrance to address shoplifting, only at employee and receiving doors to address internal theft, or at all exits, depending on the scope of the problem they are trying to solve. These decisions depend on what the retailer is trying to accomplish and the investment that makes sense for the given problem.

For the customer entrance, there is a choice of pedestal vs. overhead readers, each with their own tradeoffs.

PROS	VS	CONS
Hard Tags: · Visual deterrent · Available in dual technology to use across mixed EAS system retailers		**Hard Tags:** · Some merchandise categories are not RFID technology friendly (metals, liquids or reflective materials)
Pedestal System: · Visual deterrent at storefront · Highly reliable detection coverage due to fixed distance between pedestals · Available in dual technology so retailers can transition from traditional EAS at their investment pace		**Pedestal System:** · Design may not blend well into all storefront environments
Overhead System: · Aesthetic design can blend into any storefront design · Systems are infinitely extensible to cover large wide open exits		**Overhead System:** · Reduced merchandise display zone at front of store

Figure 5

Tagging Considerations

Before making any tagging decisions, retailers should evaluate their current situation. Some of the merchandise they buy may already be tagged with RFID, as many manufacturers are already doing RFID source tagging. In that case, the retailer may decide to accommodate those single-use tags and prioritize those categories that are already being tagged. Retailers need to consider the impact of tag format (reusable vs. single-use) on store workflow (do tags need to be removed at POS or not) and whether or not they already have the POS equipment to support the tag formats they are considering.

There are many varieties of RFID tags and labels to choose from. At the highest level is the choice between reusable vs. single use. Reusable tags have higher initial cost per tag due to

their ruggedized construction to prevent unauthorized removal. However, that higher initial cost will be amortized across multiple uses, and thereby the cost per use is often lower. Conversely, the per-use cost of a reusable tag may include in-store labor costs that the single-use tags do not require – reusable tags have to be removed at the POS and recirculated (sent and attached to new to-be-sold items).

Reusable dual tags (RFID/AM-EAS) have higher security than single-use tags, since reusable tags are difficult to remove without a detacher and have the more robust AM EAS technology, along with RFID. Single-use swing tickets or labels are less expensive but are easily removed by thieves. Some retailers, in particular those selling exclusively private label products, use sewn-in RFID tags. These are made of cloth fabric, so they are well integrated into the item of clothing. Sewn-in tags are slightly harder to remove than swing tags, but can still be cut off, unless the manufacturer places them in a hard-to-get-at location, such as between the lining and outer fabric of the garment. Some ORC units sell merchandise with original swing tickets or labels for a premium on the black market due to increased authenticity, so this can be somewhat of a deterrence to removal of the label.

	Disposable Price Tickets Integrated with RFID	RFID Labels	RFID Sewn-In Tags	Reusable Dual Tech. RFID/EAS Hard Tags	Reusable Dual Tech. 2-D RFID/EAS Hard Tags
	• One-time use • Human readable • Supply chain encoding • Lower security • Lower cost	• One-time use • Human readable • Supply chain encoding • Lower security • Lower cost	• One-time use • Human readable • Supply chain encoding • Lower security • Lower cost	• Multi-use • Not human readable • Supply chain encoding • Higher security • Lower cost	• Multi-use • Not human readable • In-Store encoding • Higher security • Higher cost
Life Cycle	One-time use: Disposable item	One-time use: Disposable item	One-time use: Disposable item	Multi-use: Easy to automate recirculation and validation	Multi-use: Easy to automate recirculation and validation
Encoding	EPC encoding completed when price ticket is created	EPC encoding completed along supply chain (OEM, DCs, etc.)	EPC encoding completed along supply chain (OEM, DCs, etc.)	EPC encoding completed along supply chain (OEM, DCs, etc.)	EPC encoding completed at store using handheld RFID mobile reader
Security	Lower security since tag can be easily removed, no visual deterrent	Lower security since label can be easily removed, no visual deterrent	Lower security since tag can be easily removed, no visual deterrent	Higher security since tag can not be easily removed w/o SuperTag detacher and includes AM-EAS technology, provides visual deterrent	Higher security since tag can not be easily removed w/o SuperTag detacher and includes AM-EAS technology, provides visual deterrent

Store Labor, Tag Cost, and Tag Effectiveness Trade-Offs

Figure 6

Some retailers, who are already tagging all their merchandise with RFID swing tickets or labels for inventory management purposes, are questioning the need to also use a conventional hard type EAS tag. The primary savings they would like to realize is reduced labor in attaching and removing the EAS hard type tags. Retailers considering this path should weigh the trade-off of the labor savings they will realize vs. the decreased effectiveness of RFID as EAS using disposable tags, compared to conventional EAS using hard tags.

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Merchandising Categories

For inventory management implementations, the categories will be those that have high mix complexity (size/color/style mix for basics) and/or those with markdown optimization challenges (seasonal and fast fashion). For LP implementations, categories choses are driven by shrink issues – these will be the high-value, high-theft-risk items.

Items with less than $3 to $5 of gross margin per sale will typical not justify the RFID investment, despite meeting other criteria. This is one reason why RFID has not taken off in grocery[9]. A small number of retailers are pursuing a strategy to tag 100% of their merchandise. In those cases, there are certain benefits that can only be gained with 100% tagging (such as unified commerce, self-checkout, or mobile checkout), and therefore they will tag some categories even if the gross margin does not justify it in isolation.

Gross margins and rate of theft should be considered in selecting items for shrink reduction. The formula is similar – if shrink for a particular item is 10%, then it probably needs $3-$5 of gross margin to justify tagging. If the shrink is 20%, then tagging at a lower gross margin can be justified.

Categories with High Potential for ROI			
Key Characteristics	**Example Categories**	**Operational Benefits**	**Financial Benefits**
Complex mix; stocked year-round	Basics: · Intimate apparel · Denim · Dress shirts	· Out-of-stocks reduced · Labor reduced or reassigned · Customer satisfaction up · Omni-channel execution	· Revenue uplift · Shrink reduction · Carrying cost reduction
Seasonal	· Fashion apparel · Seasonal items	· Markdowns reduced · Omni-channel execution	· Revenue uplift · Gross margin uplift · Shrink reduction
Display execution challenges	· Footwear · Luggage	· Better merchandising of stock on hand · Markdowns reduced	· Revenue uplift · Gross margin uplift · Reduced sales effort
High shrink risk	· Jewelry · Off-price retail	· Shrink reduced · Labor reduced or reassigned	· Lower COGS · Gross margin uplift

Figure 7, Source: ChainLink Research

[9] Grocers traditionally rely on store personnel to check and restock the shelves. They are starting to experiment with camera-equipped robots that roam the aisles and take inventory as way to prevent out-of-stocks.

Categories with Mixed Potential		
Category	Potential Leverage	Issues
Cosmetics	Mix complexity	
Sporting goods	Seasonality	Physics of technology
Consumer electronics	High-value complex assortment	Branding
Retail auto parts	Complex assortment vendor managed inventory	Tag application
		Substitutability
Wines and liquors	High-value complex assortment	Margins too low
Accessories	Detect slow-moving inventory	Turns too high
Grocery	Perishability	

Figure 8, Source: ChainLink Research

Technology Challenges

RFID tags have challenges working very close to metal and liquids. These have to some extent been overcome by tag design and placement (often with a foam or dielectric spacer to separate the tag from the liquid or metal), but some materials still cause problems. There are also challenges tagging very small items. The range of an RFID tag is dependent on many factors, including the sensitivity of the chip, electrical noise, size of inlay and other store environmental factors. One of the biggest factors is the size of the tag antenna. This is because UHF RFID tags are passive; i.e. they have no battery and are dependent on using their inlay to absorb the Radio Frequency (RF) energy emitted by the antenna. If they do not receive enough energy, the chip is not powered up and/or the returned signal is so weak that the reader cannot 'hear' it. This is important for RFID as EAS systems to confidently trigger an alarm. Therefore, it can be challenging tagging very small items, such as jewelry and cosmetics because of the inherently small form factor, leading to a small antenna. Both of these technology challenges may exist (such as foil-lined cosmetics) in the merchandise you are considering tagging. For these reasons, the physical suitability for RFID tagging of various items needs to be considered, along with the other retail store factors determining which categories and items to tag.

Why AM EAS Tags Performs Better than RFID Tags for LP

RFID devices use RF waves to communicate, providing a unique ID when they are interrogated by an RFID reader. For tagging of retail items, such as apparel, passive RFID is used, rather than active RFID[10]. Sensormatic EAS tags use AM (Acousto-Magnetic) technology, which does not provide a unique ID, but only communicates its presence, which is a single bit of information. Is a tag present or not? Sensormatic EAS tags use AM technology, emitting a 58 kHZ acoustic wave which vibrates the tag, causing a corresponding electromagnetic wave to return.

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[10] Active RFID has a battery to power it, giving it the advantage of much longer range, but they stop working once the battery runs out and they cost much more than passive RFID tags. Passive RFID uses its antenna to harvest RF (radio frequency) energy coming from the reader to power up the chip and reply with its unique ID number.

For RFID, most retailers use the RAIN standard UHF tags that use the 900-915 MH[11] frequency band in most countries. Frequency matters because lower frequency radio waves pass through water[12] much better than higher frequencies do. That is why the UHF/RAIN tags do not work as well near water. The human body is 60% water, so it blocks UHF radio waves. Hence, 'body shielding' is a challenge when using RFID tags. In contrast, the 58 kHz frequency used by the AM sensor in the LF band is more than 10,000 times lower frequency then RFID, and thereby is much less susceptible to attenuation by water.

The higher frequency of RFID also does not work as well around metal as AM tags. RFID tags are more susceptible to electromagnetic interference (EMI) than AM tags. RFID as EAS systems are installed to meet the specific retail environment to achieve optimal loss prevention merchandise protection. RFID as EAS systems require a merchandise-free zone around the entrance to provide highly reliable detection performance. Some systems use people counting technology together with RFID to differentiate between tags going out the door and RFID tags being carried by shoppers walking near the door, but not actually exiting.
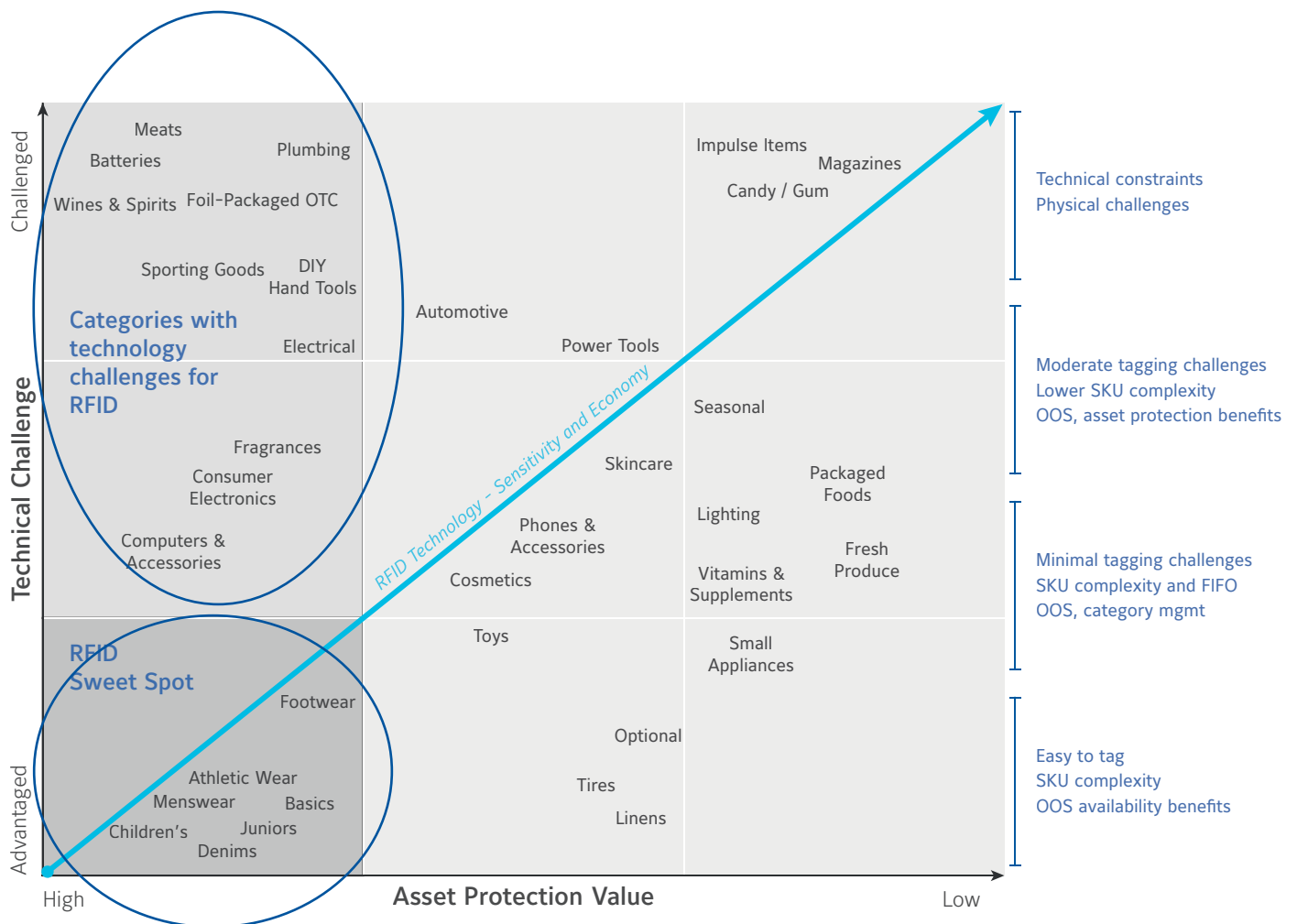

Figure 9

POS Integration

RFID as EAS with hard tags uses a similiar POS workflow as traditional EAS technology (AM and RF) and does not require integration into a POS system. Hard tags are removed from merchandise at the POS and shoppers exit without the RFID as EAS system alarming. RFID as EAS systems alarm just like traditional EAS system when hard tagged merchandise passes through exit detection zone. When using RFID swing tickets or labels that are not removed from merchandise, POS integration is needed since the merchandise leaving the store has the associated RFID sensor on the product. When using ticket or labels, the POS workflow does not require the removal of the RFID sensor. Instead, the associated EPC information is communicated through the POS system to the RFID exit system, telling it that the merchandise is valid to pass without alarming. This integration also allows for greater shrink visibility through inventory reporting when loss events occur.

Measuring the ROI of RFID for Loss Prevention

Amount of Shrink from Theft

According to NRF's 2018 National Retail Security Survey, the average shrink for US retail is 1.33% of sales. That same survey showed that shrink in the apparel sector was higher, averaging 1.7% of sales. The Sensormatic Global Shrink Index report for 2018 shows slightly higher numbers, with average shrink of US retailers at 1.85% and shrink for US fashion and accessories stores at 2.43% of sales. Both reports also break down the sources of shrink.

Internal and external theft together account for about 60% (Sensormatic Index) to 69% (NRF Survey) of shrink. Recall the NRF average shrink for apparel stores is 1.7%. Using NRF's numbers, 69% of 1.7% comes to about 1.2% of sales. That is the shrink from theft (internal + external) in apparel stores, according to the NRF survey. The Sensormatic report found 2.43% shrink for fashion and accessories stores. If we multiply that times 60% (Sensormatic's estimate of average shrink from theft), it comes to about 1.5% of sales. We conclude the average shrink from theft (internal and external) for US apparel stores is 1.2%–1.5% of sales.

Source of Inventory Shrinkage (2018 average)

Shoplifting/external (including ORC)	35.7%
Employee theft/internal	33.2%
Administrative and paperwork error	18.8%
Vendor fraud or error	5.8%
Unknown loss	6.6%
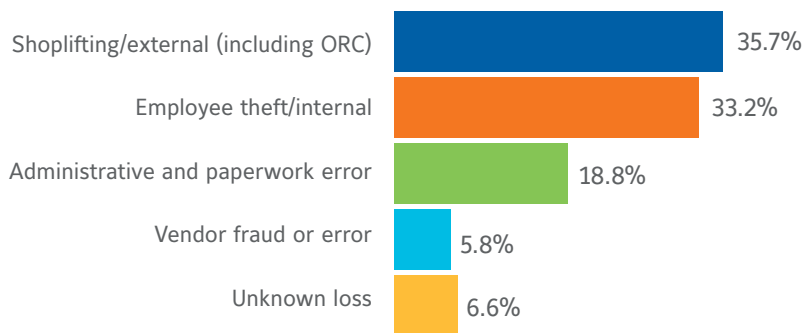
USA Retail Shrinkage - Sources, 2017–2018

Administrative Loss	18.44%
Vendor/Supplier Loss	21.47%
External/Shoplifting	35.55%
Internal/Employee	24.54%

Legend:
- Vendor/Supplier Loss
- Administrative Loss
- Internal/Employee
- External/Shoplifting
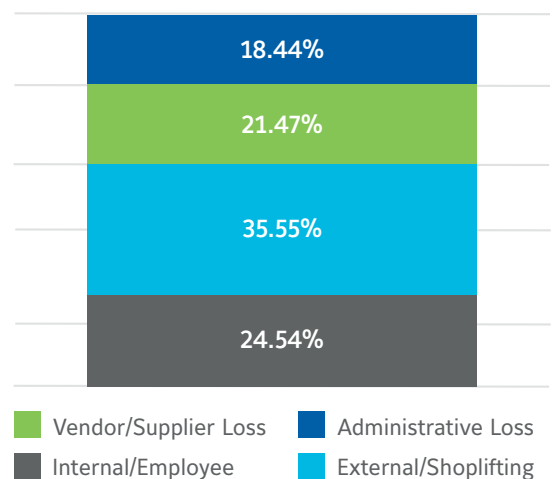
Figure 10, Sources of Shrink (Left: NRF 2018 Survey, Right: Sensormatic Shrink Index)

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Estimating Potential Shrink Reduction Using RFID as EAS

How much of that shrink from theft can be eliminated using RFID as EAS? Sensormatic estimates conventional EAS reduces shrink by about 50%. A 2016 study by Kurt Salmon on RFID in retail surveyed 60 soft-line retailers and wholesalers and found the average reduction in shrink was 33.7%. ChainLink Research finds RFID for LP reduces shrink by an average of 35%-40%, based on estimates from retailers.

We will consider 35% to be our consensus average reduction in shrink using RFID. Coincidentally, the consensus average percent of shrink from external theft (according to NRF and Sensormatic) is also 35%. Thereby, we calculate the reduction in shrink for the NRF survey (1.7% X 35% X 35% = 0.21%) and the Sensormatic Index (2.43% X 35% X 35% = 0.30%). Therefore, the estimated value of reduction in shrink from using RFID as EAS is 0.2% to 0.3% of sales.

Sales Uplift

Beyond the shrink reduction savings outlined above, RFID as EAS has the potential to result in sales uplift by reducing out-of-stocks. Each item in a store has a reorder point; when inventory falls below that point, the item is reordered from the retailer's distribution center (or from the supplier if the item is delivered by direct-store-delivery). If thieves steal more than the number of items constituting the reorder point, and nobody notices, then that item will be 'frozen' until the next cycle count, because the perpetual inventory count in the system will never reach the reorder point. Thus, the loss to the retailer is not just the items stolen, but all of the items the retailer would have sold between the time of the theft and the next cycle count. Once the cycle count is done, the perpetual inventory count will be set to zero (the correct amount, since there are no items in the store) and a replenishment will occur.

In practice, this condition does not always persist until the next cycle count for 100% of the affected items. For some items, an employee or customer will notice there is no stock[13] and will correct the perpetual inventory count to trigger a reorder or place an order manually. However, even in that case there will still likely be some lost sales between the time of the theft and the time when the mistake is noticed, and the count corrected.

Even if thieves steal somewhat less than the reorder point, and the item is fast-moving relative to the replenishment period, then it can cause a repeated cycle where inventory runs out between replenishments. Normally, the reorder point is designed to provide enough safety stock to last until the next replenishment. If there is much less safety stock, then the remaining items will all be sold before the replenishment occurs. Thus, there will be periodic out-of-stocks for that item until the next cycle count trues up the perpetual inventory count for that item. Therefore, with regard to sales uplift, stolen items will fall into one of three categories:

1. Fully Frozen—Enough of this item has been stolen that all remaining items are sold without triggering a replenishment. In this case, sales are zero until the next cycle count.

2. Partially Frozen—Replenishments are being triggered, but enough has been stolen that inventory falls to zero between replenishments and this item is regularly running out. Sales are partially eroded until the next cycle count.

3. Unfrozen—Some items were stolen, but not enough to bring the count to zero between replenishments. There may be some loss of sales because of the presentation impact of items being sparsely stocked, but that effect is likely small.

Calculating the actual sales uplift can be complicated, involving several different factors:

- Percent frozen—number of stolen items that are fully frozen, partially frozen, unfrozen. This depends on quantities being stolen relative to reorder points.

- Cycle count frequency—Yearly cycle counts create nearly twice the sales loss of 6-month counts.

- Inventory velocity—How much of the frozen item is normally sold between each cycle count, $ value of those sales

- Replenishment frequency—Less frequent replenishment increases the number of partially frozen items.

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[13] This can happen because a customer asks if there are any more in stock or an employee notices the out-of-stock, for example while straightening up the shelves and/or restocking fitting room items.

Markdown Reduction from Shrink Visibility

The sales uplift described above applies to continuously replenished items (i.e. basics). Fashion and seasonal items, that are not replenished, will also be impacted by theft beyond the loss of the stolen items. When items are stolen, the system will say there are more items in stock than there actually are. The markdown algorithms will then recommend steeper markdowns to move the inventory. If the inventory count were accurate, then the markdowns would not be as aggressive, knowing there were fewer items left. Thereby markdowns are reduced and margins improved by the accurate inventory count that Shrink Visibility provides.

Calculating the ROI for RFID as EAS

The ROI calculation depends on the cost and expected return. The cost (the 'Investment' part of the ROI calculation) consists of upfront and ongoing costs. Upfront costs include the exit systems, installation, and professional services (if any). If reusable hard tags are included, then the cost of those tags and detachers will also occur at the front end of the project. In that case, ongoing costs will be minimal, primarily to replace lost or malfunctioning tags. If single-use tags are used, then there are ongoing costs of those tags every year.

RFID as EAS

Current shrink:	2.50%	Annual $ reduction in shrink:	$6,230,000
Shrink with RFID:	1.88%	Annual sales uplift:	$2,000,000
3-year ROI:	12.5%	Payback Period:	11 quarters
Net present value:	($3,453,775)	Lowest cumulative cash flow:	($15,581,355)
Initial cash investment:	$18,688,180	<- sum of costs during the implementation period, the first 3 quarters.	

Cumulative Cash Flow
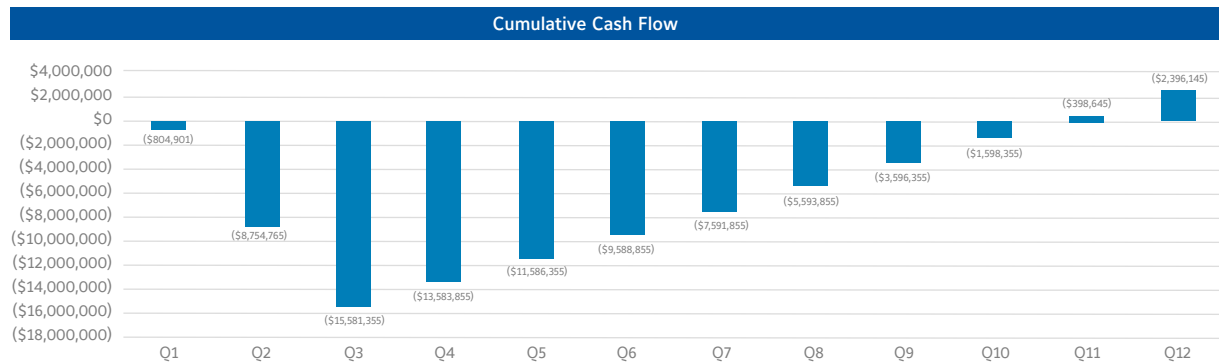
RFID Inventory Mgmt. ROI

3-year ROI:	446.6%	Payback Period:	4 quarters
Net present value:	$42,860,925	Lowest cumulative cash flow:	($4,704,090)
Initial cash investment:	$18,688,180	<- sum of costs during the implementation period, the first 3 quarters.	

Cumulative Cash Flow
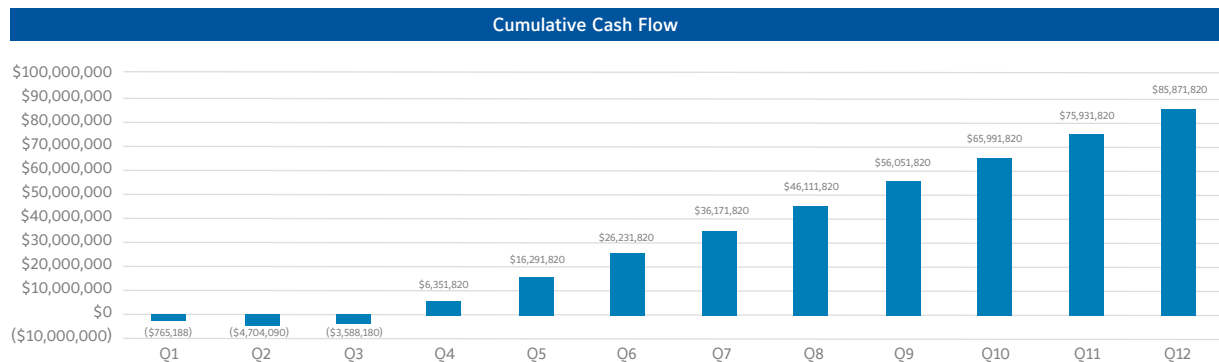
Figure 11

The cost of the tags is often the single largest component of the investment. This is dependent on the number of items being tagged. The decision of which categories of merchandise to tag determines this number and the cost and is therefore an important decision.

The size of the benefit (the 'Return' in your ROI) is dependent on the existing amount of external shrink (dollar value of goods being stolen) and the expected impact of the RFID as EAS system on reducing that shrink. As we showed above (based on numbers from NRF, Sensormatic, and Kurt Salmon), the expected reduction for most retailers will be between 0.2% to 0.3% of sales. Keep in mind, if the retailer already has an EAS system installed and is merely replacing it with RFID as EAS, they will not see any additional reductions in shrink[14].

Executives and financial professionals will also be interested in the Net Present Value (NPV) of the investment. This is used to compare different potential uses of capital and decide where to invest money. The Net Present Value calculation takes into account the time value of money. A discount rate is used when calculating NPV. The discount rate reflects the company's cost of capital. Below are example ROI reports for RFID as EAS and for inventory management, the latter generally having a more rapid ROI. When we look at the broader set of use cases, there is a broader range of financial benefits to gain as shown below.
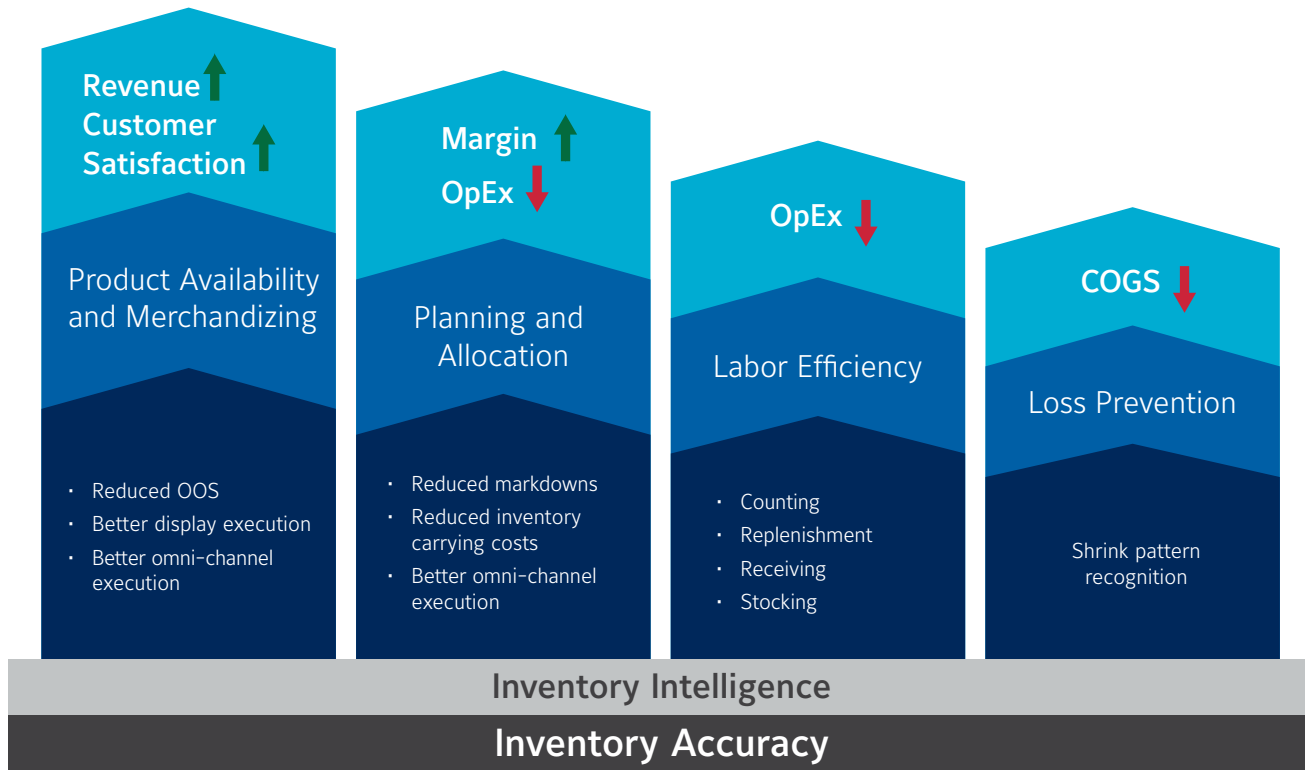
Figure 12, Source: ChainLink Research

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[14] In fact, they may see a slight increase in shrink, since RFID is not quite as effective as AM in shrink protection.

Planning Checklist

When considering RFID adoption, the retailer should decide whether to take an Inventory-first or LP-first adoption path. If going down the LP-first/RFID as EAS path, there are a number of other things to consider such as: 1) which categories of merchandise to start with, 2) what kind of tags will you use, 3) what storefront exit protection will you use, 4) which enterprise systems do you need to integrate with, and 5) what reports and business intelligence you need. Below is a checklist for these items.

1. Merchandise Categories:
Select what products you will begin tagging. Those with high mix complexity can yield the greatest results.

- [ ] Apparel
- [ ] Fashion accessories
- [ ] Footwear
- [ ] High-value theft-prone items
- [ ] Non-RFID friendly (may require special tags)

2. Tagging:
Identify what types of tags will be used, including those on existing merchandise. A mix of tag technology is OK during a pilot and transition but moving to either a dual technology or RFID only tag will maximize your investment.

- [ ] EAS-RFID dual tags (AM + RFID)
- [ ] Single-use RFID labels (e.g. tickets, labels, hang tags)
- [ ] Sewn-in RFID labels
- [ ] A mix of hard tags and labels

3. Storefront/Exit Protection Needs:
Select all your store needs for EAS protection. Several types of systems may apply. If you have a mix of tags across your merchandise, then dual technology systems will provide protection for existing and new tagging processes.

- [ ] Standard door protection (pedestal)
- [ ] Wide open exits (overhead)
- [ ] Backroom, receiving area
- [ ] Your existing EAS exit systems technology (AM or RF)
- [ ] Invisible/concealed systems

4. Enterprise Systems Integration Needs:
What key systems need to be integrated, identify by phase, starting with the most important first.

- [ ] Current EAS exit systems
- [ ] Inventory management
- [ ] Ecommerce platform
- [ ] POS
- [ ] Order management
- [ ] Supply chain
- [ ] Store operations/task management

5. Business Intelligence Needs:
Identify what data sets you want and what analytics, insights and metrics you need. These should support your use case(s).

- [ ] Inventory analytics
- [ ] Device management and monitoring
- [ ] Loss prevention analytics
- [ ] Blended or customized reporting

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Appendix A: Other Uses of RFID

In addition to the inventory management and LP uses of RFID discussed above, there are several other use cases for RFID in retail. These typically happen after an investment has been made in inventory management first.
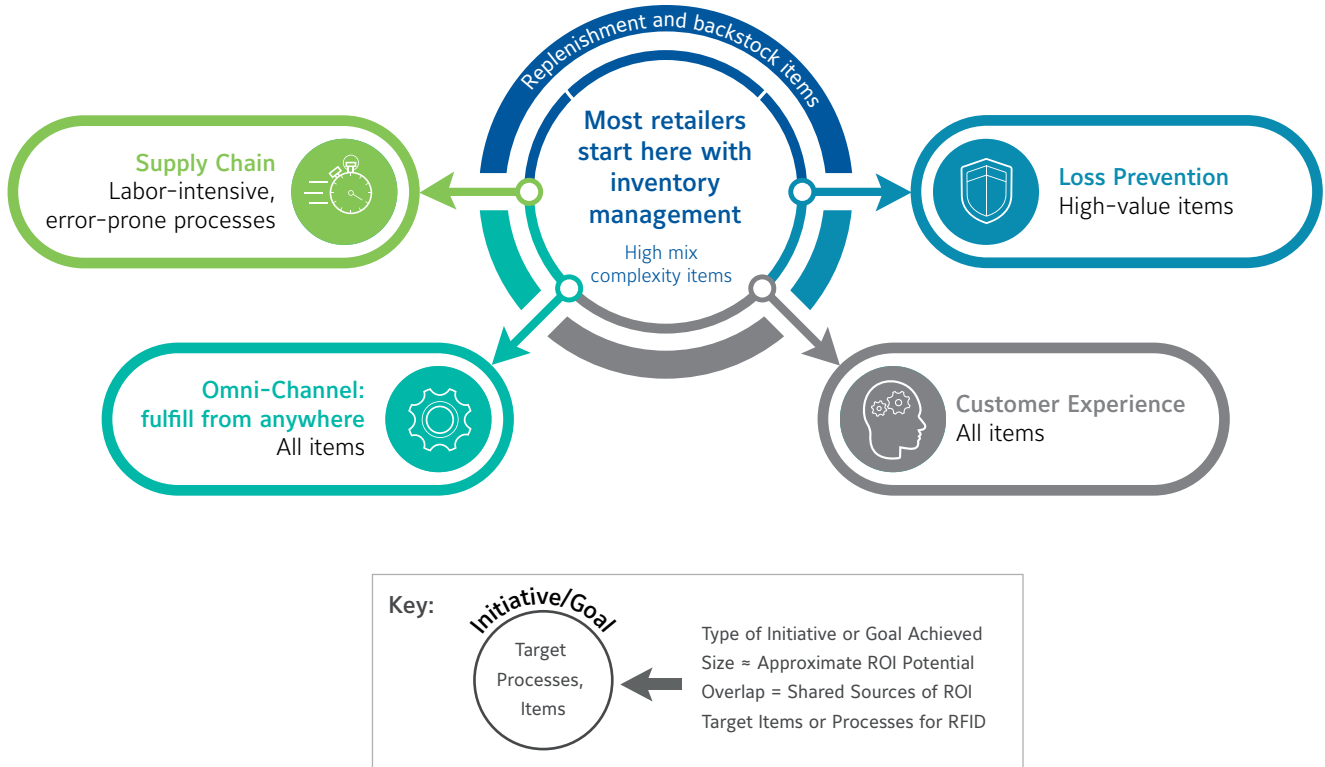
Figure 13, Source: ChainLink Research

Supply Chain

There is increasing interest in the use of RFID in the supply chain. Research by Auburn University and GS1 found drastic reductions in shipment errors when using RFID[15]. In outbound shipping operations — whether small ecommerce orders, or larger DC or store replenishment shipments — RFID can be used to confirm that the right items have been picked, packed, and loaded onto the truck. When suppliers use RFID in this way, it can greatly reduce errors and chargebacks due to incorrect items or quantities, as well as far fewer incorrect ecommerce orders being sent. The same data can be used to generate an ASN that includes not just quantities, but the serial numbers of every item. Then at receiving (whether at DC or store), RFID can be used to confirm that the shipment matches the ASN and/or order. RFID can also be used during put away at a DC to ensure the right product is being put in the right location.

When items are tagged at the source by the manufacturer, pick-pack-ship and receive verification can be done at each step throughout the chain. It is not necessary for the whole chain to implement RFID-based verification at the same time. This can happen a node or tier at a time, starting at the manufacturer, at the 3PL, or at any of the retailer's own DCs and stores.

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[15] The research, codenamed Project Zipper, looked at product information flowing between brand owners and retailers. It found that conventional approaches, using UPC barcode, had at least one error in 70 percent of the orders. Using RFID, the error rate was about 0.1%. This represents a significant decrease in chargebacks to suppliers and problems for retailers.

Unified Commerce Fulfillment

Another promising use case is omni-channel fulfillment. With RFID, retailers can have much more accurate inventory counts in the DCs and stores where they ship ecommerce orders. This enables much more reliable order promising[16]. This results in more satisfied customers, confident that the retailer will always deliver when they say they will such as Buy Online Pick Up in Store (BOPIS). RFID also provides more reliable and accurate inventory data to Distributed Order Management and fulfillment optimization engines, so those algorithms will work better and more consistently to save money for the retailer. For retailers doing their own home delivery, RFID can provide accurate tracking of delivery status, as well as electronic proof-of-delivery capabilities.

Pick to the Last Unit

Retailers are increasingly using store inventory to fulfill online orders, or to fulfill demand from other stores. If inventory counts are not accurate, then the retailer risks promising an order from store inventory that is non-existent, thus disappointing the customer. Many retailers instead take a conservative approach and don't promise down to the last unit in a store. However, some retailers, such as Macy's, have found that the inventory accuracy they gained through RFID has allowed them to now pick down to the last unit in each store, thus using up all the stock without risking an unfulfilled order promise. For more on that, see Macy's Leverages the Power of RFID to Fuel Successful Omni-Channel Fulfillment Strategy.

Product Authentication and Provenance

Some brands have looked at using RFID to prevent counterfeits, as well as combat gray market diversion (parallel import). By tagging items with RFID at the point of manufacturing, a complete list of genuine goods is maintained and can be checked. In addition, RFID could be used to designate which market each item is destined for and alert the brand owner when items are being sold into markets they were not supposed to be in. Some makers of fine wines, or other products for which provenance is key to its value, have experimented with using RFID to track and prove the provenance. The use of RFID for anti-counterfeiting, gray market deterrence, and provenance assurance is still limited.

Customer Experience

First and foremost, RFID improves the shopper's experience by reducing out-of-stocks (OOS). Having the specific item that the consumer wants in stock when they come to the store is of prime importance. Beyond reducing OOSs, some retailers have experimented with smart fitting rooms. The fitting room has a touch-screen interface that senses what RFID tagged items the shopper has brought into the fitting room and is able to suggest accessories that go with it. The user can send information about the merchandise to their mobile device. And they can request assistance from a store associate, such as bringing other sizes, colors, or accessories to them.

RFID also has the potential for nearly instant self-checkout or mobile checkout, where the entire cart is read with a single scan. In 2017, Japan's Ministry of Economy, Trade and Industry (METI) announced an agreement with five major convenience stores[17] to use RFID tags on all products sold in their stores by 2025. They estimated this will be about 100 billion[18] products being tagged with RFID annually.

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[16] RFID helps improve order promising reliability regardless of where the order is placed and the promise made (online, in the store, via phone, etc.) and where the order is delivered (to the home, store, locker, etc.)
[17] Seven-Eleven Japan, FamilyMart, Lawson, Ministop, and New Days
[18] That would be about 6½ times as many RFID tags as shipped worldwide in 2018, when 15.4 billion RFID chips shipped.

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If we take an end-to-end view, there are many potential places RFID use is envisioned:

Source Tagging
RFID tags applied, tested, verified at the manufacturing line.

Ship Verification
Verify correct items being shipped just before loading into container or vehicle.

DC Bypass
Automatic routing based on item-level visibility. Sort and repack verification, as needed.

More Frequent, Accurate Cycle Counts
Greatly reduced labor; higher accuracy.

Receipt Verification
Automatic comparison of items received against the order and ASN.

Item-Level Shelf Replenishment
Store associates auto-notified when items need replenishing on store shelf.

Smart Mirror/Fitting Room
Enhanced customer experience.

Instant Self-Checkout
All items scanned at once, instantly.

Validated Returns
Validation based on serial number reduces fraudulent returns.

Service & Warranty
Automatic warranty verification. Module/product revision-level tracking. Repair history.

| Supplier |
| Carrier/3PL |
| Deconsolidation |
| Retailer DC |
| Store |
| Consumer |
| Service, Repair, Returns |

Pack Verification
Verify correct items packed and correct working tags just before sealing cartons.

In-Transit Visibility
Item- or case-level visibility at each hand-off throughout journey, including (if needed) condition/temperature monitoring.

Merge-in-Transit
Precise in-transit visibility enables precise coordination of multiple shipments.

Loss Prevention
Readers on facility's exits, combined with highly accurate inventory, deters theft. Replacing EAS systems in some stores.

More Frequent Store Replenishment
More precision in timing and quantities needed.

Fulfill From Anywhere
Precise and up-to-date perpetual inventory enables fulfill from anywhere, including other stores.

Provenance & Authenticity
Retailers and consumers can confirm the authenticity of luxury goods or the provenance of fine wines and other gourmet items.

Returns Center Logistics
Tracking of items throughout unpack, inspection, repair, repack, ship.

Figure 14, Source: ChainLink Research

Fast Forwarding Retail

About Sensormatic Solutions

Sensormatic Solutions is the leading global retail solutions portfolio of Johnson Controls enabling smart and connected shopper engagement. By combining critical insights into retail inventory, shopper traffic and loss prevention, Sensormatic Solutions powers operational excellence at scale and helps create unique shopping experiences. Our solutions deliver real-time visibility and predictive analytics for accurate decision-making across the enterprise, enabling retailers to confidently move into the future. With more than 1.5 million data collection devices in the retail marketplace, we capture 40 billion shopper visits and track and protect billions of items each year. Our retail portfolio features the premier Sensormatic®, ShopperTrak® and TrueVUE™ brands.

For more information, visit **www.sensormatic.com** or follow us on **LinkedIn**, **Twitter**, and our **YouTube channel**.

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