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RFID Moves to the Cloud: New Opportunities Emerge for Enterprise Solution Providers

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Author:
John Gole

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A Familiar Technology That Still Manages to Surprise

Over the past 15 years, radio frequency identification (RFID) systems have helped companies in multiple industries to track their inventories and understand the flow of complex portfolios of products more efficiently through their supply chains. The apparel industry is the best-known example, finding significant adoption in retailing, supply chains, and manufacturing. But RFID is also proving to be a critical enabler of digitalization beyond apparel, gaining widespread use in diverse fields such as automotive manufacturing, healthcare, and logistics.

RFID has a long track record and is now widely used across many industries. There are several types of RFID solutions that enable tags to be read from different distances, from close contact up to dozens of meters away. Such distances enable entire pallets and shopping carts to be read at a distance by an RFID reader located in a warehouse bay, a retail stockroom, a cashier's line, or a security gate at the exit of a store.

Because RFID technology has been refined, tested, and proven in large deployments, enterprises and vendors have developed many different use cases that can leverage the technology and the data it generates. These use cases include increased efficiency in distribution systems and in-store inventory analysis, optimized store operations, and improved security. These use cases affect the bottom line in multiple ways: they increase efficiency, reduce theft and losses, and increase sales by ensuring the right item is available and can be found in stock.

Vertically integrated players have been key drivers in the adoption of RFID, as they could apply RFID tags in manufacturing to gain benefits downstream. These players can track items from production all the way to the customer's hands in a single integrated system. With that complete end-to-end visibility, they can quickly route items to the stores where they are needed, improve omni-channel operations, guarantee product authenticity, and take tight control over every aspect of their brands.

As adoption spread across the industry, less vertically integrated players also gained many of the same RFID advantages, though full end-to-end item-level visibility has been a challenge that is now being solved. By moving their RFID data to the cloud and combining with partners up and down the value chain, companies gain the complete end-to-end visibility on individual items that is necessary for them to achieve new gains, such as verifying product origins, ensuring ethical production and recycling, and increasing safety in management of food and pharmaceuticals.

These new use cases for using RFID data to track the life cycle of an item require a cloud-based platform that all stakeholders can access. The enterprises relying on RFID item tracking will need help from their software and solution providers to incorporate these cloud data points into their management systems.

Key Implications for Enterprise Software and Solution Providers

For enterprise software and solution providers, this has implications:

- RFID systems will continue to be incorporated into supply chain and other enterprise management systems.
- Cloud platforms for RFID end-to-end item-level tracking create opportunities to sell new features and use cases to their installed base of current customers.
- A leadership role in enabling these platforms can help to further differentiate providers from the pack.
- These platforms will generate a tremendous amount of new data, offering huge value for customers but also creating new demand for storage, workloads, analytics, and solution development.

Understanding RFID

RFID enables the easy identification and tracking of items with the use of a small RFID tag that is placed on each item, much like a barcode tag, and an RFID tag reader that can scan the tag from a distance typically ranging from centimeters up to dozens of meters away, depending on the type of RFID technology used. The tag readers activate the tag using the appropriate radio frequency, and the tag transmits its encoded identifying data back to the reader. Importantly, unlike barcodes, certain types of RFID technologies do not require line of sight for tag reading. With this critical functionality, organizations can dramatically transform how they manage the flow of goods and the tracking of assets throughout their organizations, supply chains, and distribution.

The most common RFID systems use passive tags. The tags include a small antenna and chip with limited functionality, so that they can be produced inexpensively enough to be part of the packaging. These tags are powered by the radio signal sent from the tag reader. As a result, they do not require local battery power, which saves on cost and complexity.

When the tag receives the signal from the reader, the tag "wakes up" and transmits the data encoded in the tag, which typically includes a code number that references the product description (essentially the barcode SKU) as well as a unique identifier, which is a serial number. This data is received by the tag reader and then forwarded to the enterprise software systems.

FIGURE 1

How RFID Works

The RFID tag includes an antenna and microchip for storing and transmitting encoded data when prompted by a reader.

The RFID tag reader sends a radio signal that powers the tag and prompts a reply. The reader then receives the tag's data and forwards to enterprise applications.

Middleware sends the data to enterprise applications in datacenters and the cloud, where it is stored and used for functions such as inventory management, reordering, and expiry date management.

Source: IDC, 2021

Different Types of RFID to Serve a Range of Purposes

Passive RFID tags bring significant advantages that are ideal for low cost and long lifetime. However, some use cases have differing requirements. In addition to passive RFID, there are other types of RFID systems. Some use a battery-assisted passive tag, which increases the read range to over 30 meters. There are also active tags that incorporate more advanced circuitry and can be read at even greater distances of 100 meters or more.

NFC chips utilize high-frequency (HF) RFID. In some cases, such as smartphones, it can be bidirectional to enable the sharing of data both ways within a short range of a few centimeters. However, NFC can only read one item at a time, whereas other RFID systems, such as UHF RFID, can read many tags at once.

A Range of Frequencies Addressing Different Uses

Among passive RFID tags, there are multiple frequency options:

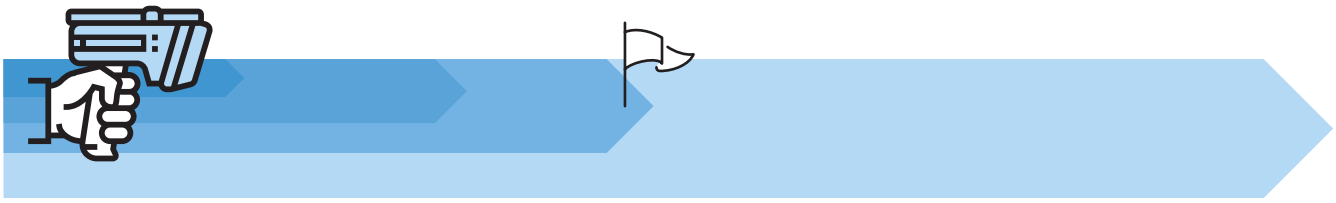
- **Low frequencies** (120KHz to 150KHz) enable reading from short distances, ranging from direct contact to 10cm away. LF RFID is often used for access control systems and animal tracking.
- **High frequencies** (from 13.56MHz) can be read from around 30cm. HF RFID is often used in ticketing and payment systems, as well as NFC systems.
- **Ultra-high frequencies** (860MHz to 960MHz) enable RFID tags to be read from up to five or six meters away. These UHF tags are particularly well suited for item-level tagging, in which large numbers of items are read on shelves or pallets, or as they pass through steps in a supply chain.

The combination of UHF RFID's greater range and the ability to read many tags at once from a single reader makes passive UHF RFID the most common type used in supply chain and inventory management, and it is the RFID technology with the largest volumes of tags currently deployed. This study focuses primarily on the ways that UHF RFID is being adopted across industries.

FIGURE 2

Common Types and Frequencies of RFID

	Passive RFID			Active RFID
Type	**LF**	**HF**	**UHF**	**Active UHF**
Frequency	120KHz–150KHz	13.56MHz	860MHz–960MHz	860MHz–960MHz
Distance	~10cm	~30cm	~5m–6m; even farther for some types	Up to 100m



UHF RFID tends to be the sweet spot for supply chain and inventory management.

Source: IDC, 2021

RFID's Impact in the Apparel Industry

RFID in Apparel Retailing

RFID is probably best known for its role in the retail space and especially in apparel retailing. By labeling each product with a low-cost RFID tag, retailers such as Target, Inditex (the owner of Zara and other brands), and Decathlon can optimize their inventory management and accelerate reordering and restocking of popular items. They can also optimize their other store operations, such as locating misplaced products, reducing shoplifting, and accelerating checkout lines. Altogether, these improvements create higher customer satisfaction and increased sales while cutting costs from several key processes.

Manufacturing and Distribution Are Critical Too

RFID is also a critical tool upstream from these retailers. Manufacturers such as adidas and Nike produce a vast number of products with different product SKUs. For example, each product design may have dozens of different sizes, colors, and features, and each of those variations requires its own SKU. Manufacturers must supply the right volume of each variety to distributors and retailers, and then replenish the right items in each location to keep customers happy and avoid lost sales. As retailers order new units, manufacturers and distributors must route those specific items quickly to the retailer to restock the shelves. Manufacturing, distribution, and retail are therefore all tightly linked in a complex global supply chain that must manage huge numbers of specific SKUs and millions or even billions of individual items.

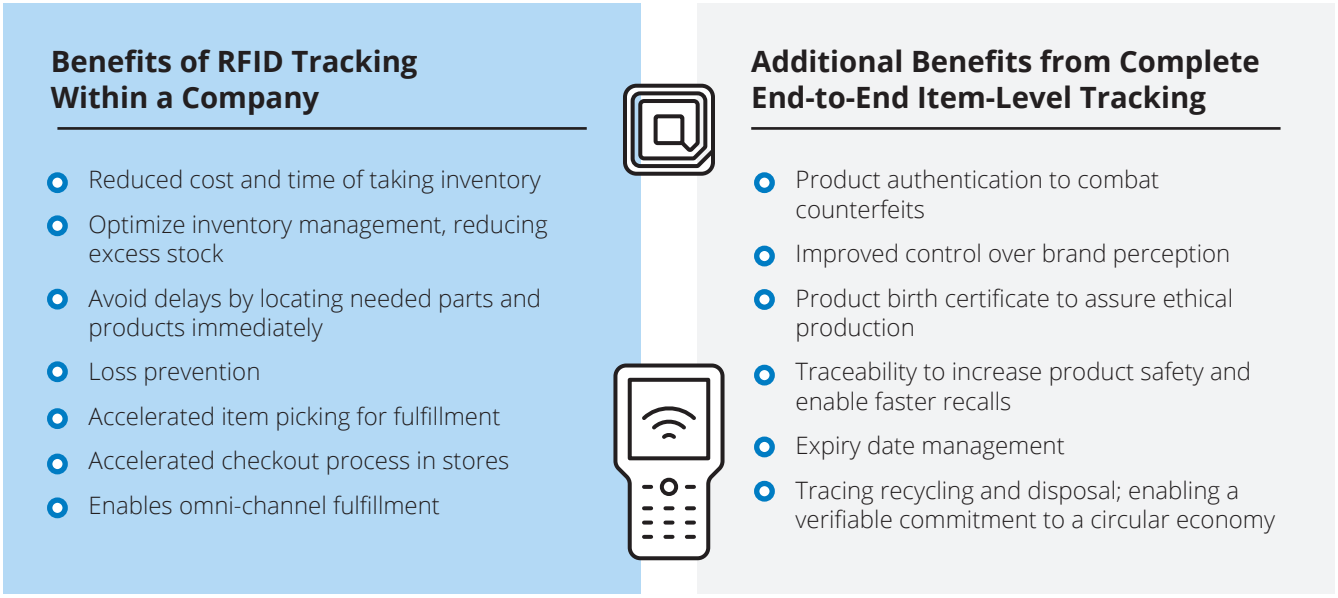
The ability to manage this complexity and respond quickly to demand has helped many companies to transform retail operations during the COVID-19 pandemic. Because they have had visibility on inventory across all locations, retail stores have been able to convert to omni-channel fulfillment centers. Customers are able to see which stores have stock and place an order, after which staff could pick the item and hold it for curbside pickup, or another store could ship the item to the preferred store or directly to the customer's home.

An Important Shift to Item-Level RFID Tracking

While tracking the SKU numbers enables companies to maintain adequate stocks of each product type, RFID use is moving to another level of granularity and tracking individual items. By tracking the serial numbers of individual items, companies can trace the path of an individual item through its whole life cycle, and companies are developing new use cases that leverage that item-level data.

FIGURE 3

Selected Benefits of End-to-End Item-Level Tracking with RFID



Source: IDC, 2021

For example, a company can use item-level tracking to verify where a product was produced, so that the product can be authenticated. As a result, a luxury goods producer can identify and eliminate counterfeit products. By eliminating counterfeits, they not only increase sales, but they can also gain tighter control over brand perception, ensuring inferior products do not spoil the customer experience. In some industries, such as pharmaceuticals, counterfeit products can put lives at risk.

Another key benefit of item-level tracking is being able to investigate accidents and facilitate recalls after purchase. In the food industry, if a batch of food has been contaminated, end-to-end tracking enables easy tracing upstream to an item's origins and then back downstream to identify and remove other items from that batch from shelves and to alert customers.

Expiry management is a third key benefit. When individual items can be tracked, a company can manage the expiry date, prioritizing shipping of products before expiration, discounting products nearing expiry (thereby reducing waste), and removing expired products from shelves, for both safety and quality benefits.

Companies can also use end-to-end item tracking to commit to ethical business practices and a sustainable circular economy. For example, a company can identify where a product was produced and demonstrate that those facilities have ethical employment practices. The company can also verify if materials used were from recycled waste. It can later retrieve the product at end-of-life to repurpose or recycle it further.

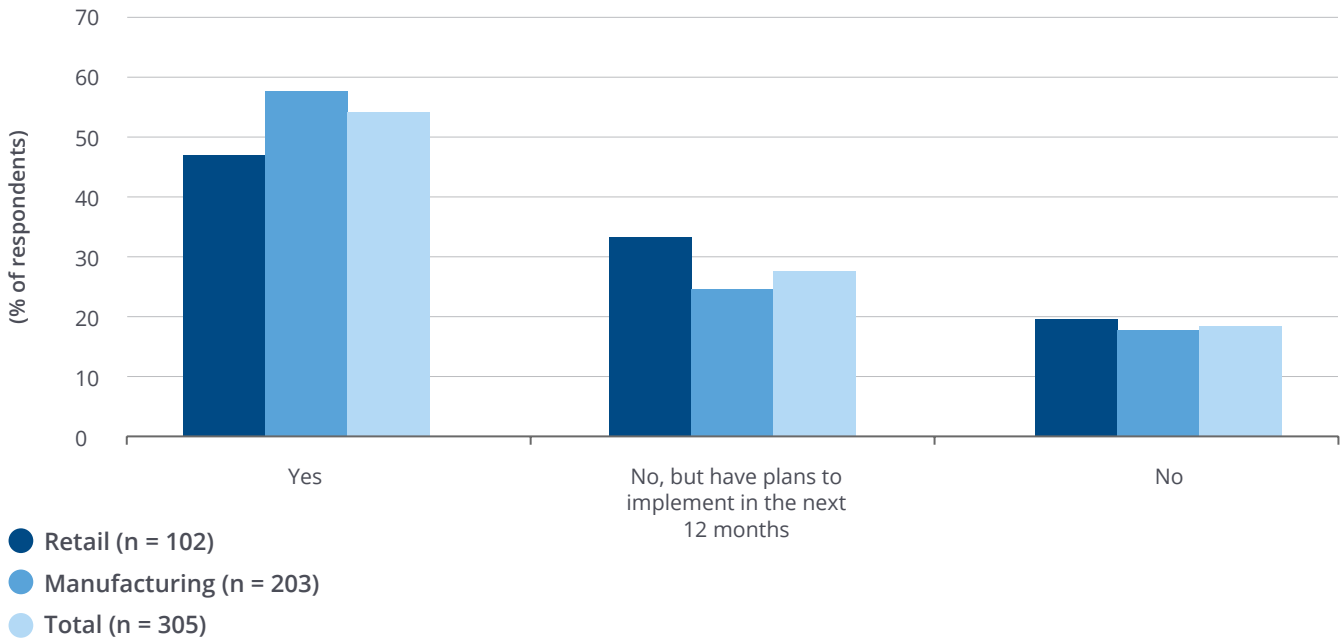
While these applications are technically possible with other trigger technologies, such as 2D barcodes or QR codes, the frequent scanning of the codes would be cost prohibitive and inefficient. In contrast, the ability to rapidly scan multiple items with UHF RFID enables efficient tracking of items through the supply chain and makes these use cases economically viable.

Item-Level RFID Tracking Is Impacting Multiple Industries

Recent IDC research has identified strong interest in item-level RFID tracking. In an April 2021 survey of North American retailers and manufacturers with more than 1,000 employees, nearly half of retailers and just over half of manufacturers said they already use RFID tags for item-level tagging of inventory, and many more plan to add it soon. The respondents were selected from a wide range of industries, including food and beverage, metals and mining, consumer durables, chemicals and petroleum refining, and automotive manufacturing. Only a small share of respondents (less than a fifth) said they have no plans to use item-level RFID tagging of inventory (see Figure 4).

FIGURE 4

Usage of Item-Level RFID Tagging



Q. Do you currently use item-level RFID tagging of inventory?

Source: IDC's Supply Chain Survey, December 2020

The rise in item-level RFID tracking is making RFID attractive across multiple industries:

Beauty products: With small premium products and many varieties, RFID enables efficient inventory monitoring, replenishment, expiry date management, and ingredient visibility. Item-level tracking reduces counterfeits, preventing them from stealing sales and from damaging brand perception. It also inhibits gray-market diversion, in which products are resold by unauthorized dealers on online marketplaces.

Food industry: Item-level RFID enables companies to ensure safe ingredients and production, increasing product safety. Companies can also manage expiry dates, verify transport conditions, and identify batches for recall purposes.

Automotive industry: Item-level RFID ensures the right parts are installed, enables quality-control checks to verify specifications from a distance, enables more efficient maintenance controls by tagging individual parts such as tires, ensures traceability and recalls for safety purposes, and enables each vehicle to be delivered to the right new owner.

Pharmaceuticals and healthcare: Supplies can be authenticated, avoiding counterfeits. Large numbers of small packages can be easily inventoried, reordered, shipped, and tracked. Abuse of controlled substances can be reduced by restricting access to specific staff RFID keys, and then scanning inventory and tracking which supplies are removed by each staff member. Expiry dates can be managed to ensure safe disposal, eliminating mistakes or theft. And transport conditions can be tracked to ensure product safety, as in the case of vaccines that must be kept at very low temperatures.

Electronics: Item-level RFID enables management of a complex supply chain and combating of counterfeits. Tracing the life cycle enables producers to meet commitments for ethical production and recycling.

Cloud-Based RFID Platforms: A Key Enabler for End-to-End Tracking

To achieve the benefits of end-to-end item-level tracking, a company requires visibility on the item-level data at all stages of the life cycle. Gaining that visibility is relatively easy for vertically integrated companies, but it is a bigger challenge for more fragmented industries. In cases where items change hands across suppliers, distributors, and retailers, the RFID tracking data may become balkanized. Each participant in the value chain may have very limited visibility. As a result, the participants in that supply chain may be unable to reap the benefits of end-to-end item-level tracking, putting them at a disadvantage.

To address this challenge, cloud-based platforms are emerging to enable companies to share item-level RFID data with authorized partners. Sharing this sensitive enterprise data must be done carefully. To make a shared data platform viable, it must enable all the participants to upload and access relevant data on a controlled basis. Authorized stakeholders must be able to access data under predetermined policies, while being restricted from accessing data that might be confidential or significant for competitive or privacy reasons.

A cloud-based platform is ideal in this situation. It enables participants to contribute and access relevant item-level RFID data across the item's life cycle and to pull that data into their internal planning systems as needed. It enables policies to determine which companies have access to which data and it enables those partners to access data from a shared public cloud rather than giving them access to the internal company IT systems. By utilizing a shared cloud for end-to-end item-level RFID data, fragmented industries can implement the same new use cases for item-level tracking that their vertically integrated rivals are implementing.

Opportunities for Software and Solution Providers

As companies move to adopt end-to-end item-level tracking, they will lean on their solution vendors and integrators to enable the new use cases — creating opportunities for the vendors.

Direct Benefits: Driving Sales and Demonstrating Commitment to Customer Priorities

The most direct benefit is that it creates new solutions and features that vendors can offer their existing customers. Vendors may add these new features for current customers of supply chain management, inventory management, and other enterprise IT systems. That could include integration of existing systems with the new sources of partner RFID data in the cloud and application development to address the new use cases.

In addition to expanding sales to existing customers, supporting this cloud-based end-to-end item tracking could help to reinforce the vendor's positioning at the leading edge of current market trends. There are several crucial themes that enterprises have recently embraced as high priorities and that vendors have put at the center of their marketing messaging. End-to-end item-level tracking nicely aligns with all of them:

The **cloudification** of enterprise IT is an ongoing process and a key trend that vendors are putting at the center of their strategies. Supporting shared RFID data in the cloud is one way to demonstrate a vendor is delivering on the promises of cloudification, both in terms of greater efficiency and in creating new value.

Sustainability is becoming a key priority for many enterprises. Vendors can emphasize the ways that RFID end-to-end tracking can help companies deliver on sustainability goals in innovative ways, such as ensuring ethical production, environmentally friendly materials, reuse, and recycling.

Customer experience is another crucial theme in enterprise decision making right now, and vendors can highlight the use cases in which RFID tracking can help enterprises to improve customer experience. These include ensuring customers can obtain their preferred item, making it easy to find that item, providing frictionless checkout, and even using stores as fulfillment centers for online ordering and in-store pickup.

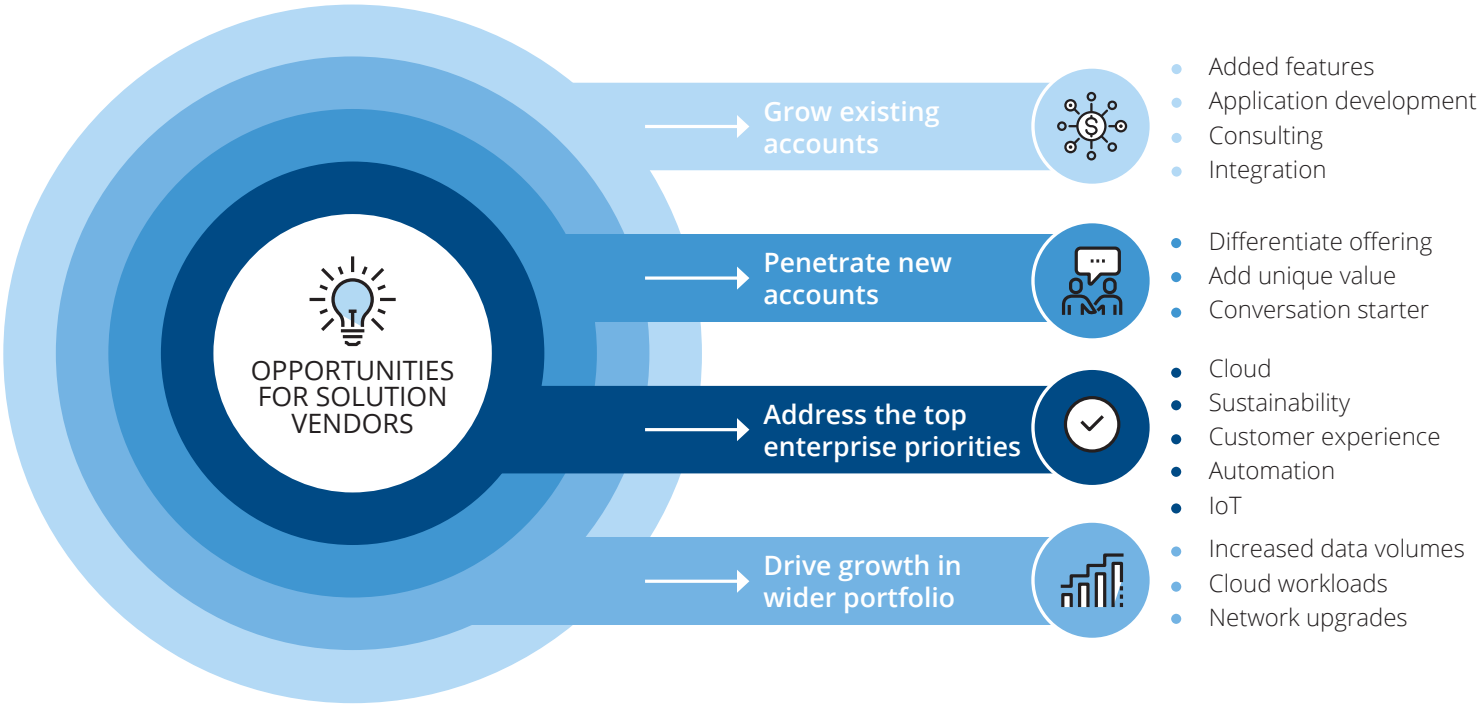
Automation is yet another critical theme for enterprises, as labor shortages are straining companies' ability to meet demand, while COVID-19 has forced many companies to reduce onsite staff. Vendors can highlight several RFID item-level tracking use cases that align with this strategic imperative, such as automating inventory counts and enabling automated item picking at warehouses.

The Internet of Things (IoT) is popular among enterprises. IoT is enabling enterprises to automatically monitor sensors, collect data, develop new data-driven business insights, and automate systems and processes throughout their operations. As a tool for collecting and tracking data throughout the enterprise, RFID has a close relationship with IoT. Many RFID readers are essentially IoT data-collection devices. Additionally, RFID addresses a gap in IoT's abilities. IoT devices are typically too expensive to enable tracking of individual packages and products, while low-cost RFID tags perfectly meet that need, making RFID a crucial part of many IoT solutions.

The fact that RFID item-tracking solutions align so well with current enterprise IT priorities suggests that vendors can leverage this technology to demonstrate their commitment to those priorities and use it as an example of the ways they address those priorities. As such, end-to-end item-level tracking could be an important differentiator and conversation starter that might help vendors to generate new business.

FIGURE 5

End-to-End Item-Level RFID Tracking Creates Opportunities for Vendors



Source: IDC's Supply Chain Survey, December 2020

Indirect Benefits: Stimulating Use of Adjacent Services

Supporting end-to-end item tracking could benefit vendors in another crucial way by increasing consumption of the vendor's adjacent services. One way it could stimulate greater consumption is by dramatically increasing the volume of data generated, collected, and utilized. To understand this effect, let's consider how this might evolve.

Data volumes in the legacy era of barcodes: When companies use barcodes, scanning them can be tricky. Because barcodes on individual items are often concealed (inside of a garment, beneath other items, on a hidden part of the item, damaged, or inside a larger package), packages and pallets are scanned, rather than individual items. Scanning tends to require manual effort, making it costly and subject to omission. When individual items must be scanned, it requires manual effort. Across large volumes of items, that effort amounts to significant costs. Individual items may only be scanned when picked in a warehouse, purchased at a shop, or scanned during infrequent inventory counts. And when they are scanned, it is likely that only the SKU is recorded, such that a count of items per SKU is collected, but not the list of serial numbers.

Item-level tracking with RFID: When companies use RFID for item-level tracking, the volume of data generated will expand rapidly. Rather than scanning a single pallet, the hundreds of items inside can be scanned individually, increasing the data volume by orders of magnitude. The amount of data per item increases as well. Rather than counting, for example, that there are 25 items in stock with a common SKU, item-level tracking records each item's unique identifier (serial number), SKU, and the time and location of the scan. So rather than recording an SKU number and a count (25), the system records 25 detailed records that can be linked to the history of that item and all other scans. Once again, the data volume increases by orders of magnitude. This much larger flow of data must now be collected, stored, and analyzed. The data may need to be used onsite, requiring edge computing resources, and sent to the enterprise cloud.

End-to-end item-level tracking with RFID: Adding the end-to-end tracking by sharing data with upstream and downstream partners increases data flows further. The enterprise applications begin leveraging the item-tracking data from partners, a much greater volume of data is available to applications, and new applications utilize that data to address new use cases.

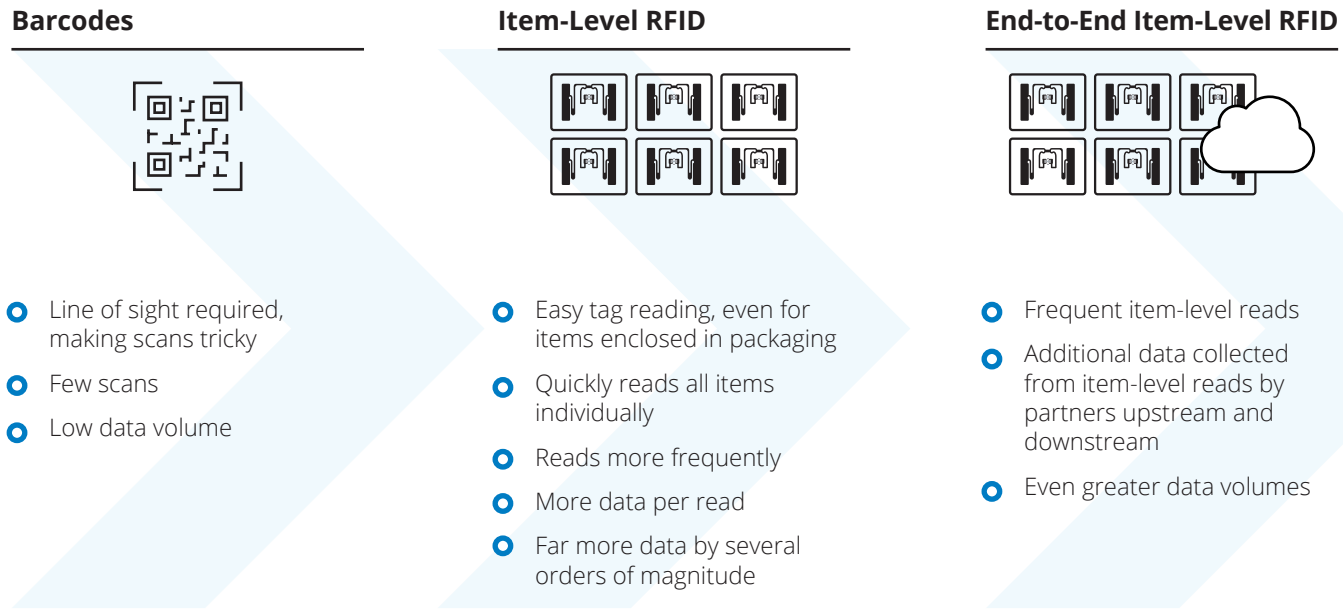
What effect does the increased data volume have on the vendor's services? There could be several effects:

- The enterprise may need to modernize its local networks. The increased data flows may push existing networks beyond their limits, while the new use cases may need greater reliability than legacy systems did.
- The enterprise also may need to modernize its WAN connections. Higher bandwidth and reliability may be called for. For those that have not yet migrated to SD-WAN, this may be the time to do so.
- The enterprise may need to deploy edge computing devices to process and manage the data onsite and route the necessary data up to the cloud.
- That data will also require much greater usage of cloud storage and compute, as well as application platforms, analytics, and other systems.

Supporting enterprise access to cloud-based end-to-end item tracking can be a boon for solution vendors and integrators. It can drive new sales to established customers, differentiate the vendor as it targets new customers, reinforce the vendor's commitment to the themes that are currently high priorities for enterprises, and increase utilization of the vendor's adjacent services.

FIGURE 6

End-to-End Item-Level RFID Tracking Generates Far More Data



Source: IDC, 2021

Next Steps for Vendors

This document has demonstrated that using item-level RFID to track the full end-to-end life cycle of products and components creates a range of new benefits for enterprises, while also creating significant new opportunities for the solution providers and integrators that serve those enterprises. How should those solution providers and integrators respond to these opportunities? There are several steps they might take:

1

Understand client needs: Vendors should begin with an evaluation phase that examines the opportunity and technical implications. Vendors should explore the interest level among their customers and see how some of the key use cases resonate with those customers.

2

Develop a product road map: Vendors should consider how item-level end-to-end RFID tracking might enable new features within their existing solutions. Is there a value proposition that could easily extend their existing offering? Which use cases could they develop first and at lowest cost?

3

Identify partners: Vendors should explore the opportunities with partners and establish initial partnerships to co-develop initial proofs of concept.

4

Examine the technical impact: Vendors should undertake an initial evaluation of what technology and skills would be needed to implement the new solutions and features. Would it simply be a matter of implementing APIs to enable a connection to the cloud-based RFID data platforms? How could the vendor enable those new use cases? What development work would be required to support the item-level RFID data sharing and incorporate it into their solutions?

5

Incorporate APIs to enable customers to connect to RFID item-level clouds: The first concrete step forward is to work with RFID cloud platforms and incorporate APIs, so that customers can connect and leverage data from those platforms.

6

Establish proofs of concept: Vendors can support new use cases incrementally, without a need to place big bets up front. They can identify customers that would like to collaborate in a proof of concept or limited trial, so both sides can test viability and identify technical requirements and challenges.

7

Develop new use cases: Vendors can start small with some of the more modest use cases that will require limited development work. With these limited early steps, vendors can gain the insight they need to make calculated investments and scale up their efforts as and when customer demand warrants it.

RFID is a proven technology that is becoming even more useful as it enables end-to-end item-level tracking. Solution vendors and integrators should investigate the opportunities this technology can create for them.

About Us

Avery Dennison RFID solutions provide a suite of digital ID technologies that authenticate product history, provide tracking and inventory solutions and enable richer consumer encounters. With our unique combination of materials expertise, innovative, end-to-end technologies and global capacity for supporting customers, the Avery Dennison Smartrac division is partnering with companies across far-reaching industries (from Food and Apparel, to Beauty, Automotive and Healthcare), introducing transformative benefits through connecting the physical and digital worlds. Supply-chain visibility and operational performance; traceability and tracking; inventory management; brand safety, ingredients and storage integrity: all can be improved and made possible through the introduction of RFID technologies.

To learn more about our RFID solutions or to speak with our experts:

Website: rfid.averydennison.com

Email: rfid.info@averydennison.com

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IDC UK

5th Floor, Ealing Cross,
85 Uxbridge Road
London
W5 5TH, United Kingdom
44.208.987.7100
Twitter: @IDC
idc-community.com
www.idc.com

Corporate Headquarters

140 Kendrick Street,
Building B, Needham,
MA 02494 USA
508.872.8200
www.idc.com

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