

# Autonomous Retail Whitepaper

Improve Inventory Visibility and Fulfillment with Emerging Technologies and GS1 Standards



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This white paper serves to document the analysis, impressions, and insights in order to support the on-going industry efforts to identify solutions to the challenges. The information contained herein is voluntary, not mandatory. It should be noted that use of the words “must” and “require” throughout this document relate exclusively to technical recommendations for the proper application of the standards to support the integrity of an implementation. The information contained herein is for informational purposes only as a convenience and does not constitute legal advice or a substitute for legal counsel. GS1 US Inc. assumes no liability for the use or interpretation of the information contained herein.

## Abstract

COVID-19 and the global pandemic have caused consumer behavior to seismically shift—away from physical browsing and in-store shopping to reliance on e-commerce search and fulfillment. This has fundamentally changed how retailers and brands must support purchase decisions—pulling forward digital transformation by 3-5 years.<sup>1</sup>

What was once a tactile consumer experience has become primarily virtual. Consumers' decisions for new and replacement purchases are now won or lost through the online story told via complete and accurate information, or lack thereof. Consumer expectations for on-time, anywhere fulfillment have never been greater, requiring the data and technology to ensure satisfaction and delight. And just like that, implementing Autonomous Retail becomes the game changer in 2021 and beyond. The result is that leading retailers and brands must invest in technology and supporting standards that harness precise identity—to achieve accurate search results, inventory management, and faster fulfillment.

GS1 Standards, the most widely used system of supply chain standards in the world, provide the means for retailers and brands to maximize their technology investment with the framework of identify, capture, and share. This ensures the availability of consistent, comprehensive information across the entire supply chain, throughout the product lifecycle.

The purpose of this whitepaper is to:

- 1.** Explore challenges of inventory visibility and fulfillment profitability—for brands, grocers, and mass merchants.
- 2.** Highlight autonomous technologies and other enablers that help solve for the challenges.
- 3.** Shed light on how industry can approach solving some problems with autonomous retail in a “good, better, best” methodology to match investment with positive outcomes.

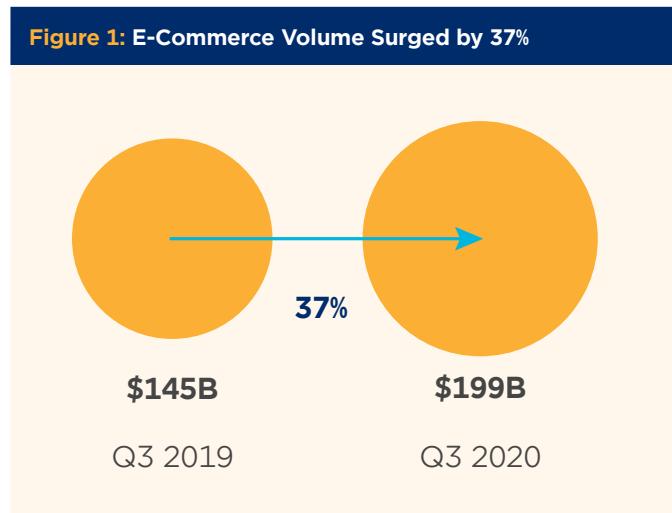
<sup>1</sup>Jul 2020, PracticalEcommerce. *Covid-19 Accelerates Retail's Digital Transformation*. <https://www.practicalecommerce.com/covid-19-accelerates-retails-digital-transformation>

## Retail Shifts—Accelerated by COVID-19

Lockdowns and quarantines created e-commerce volume spikes throughout 2020 comparable to Black Friday levels (Figure 1). At the same time, consumer buying patterns changed rapidly from essentials to lifestyle to luxury, back to essentials. This has created an unprecedented stress on traditional supply chains and fulfillment processes. In response, larger retailers have accelerated investments in digital transformation. In many cases, the pivot to online led to a focus on essentials, fewer products, and greater demands on larger brands for reliable supply.

Additionally, the landscape has changed such that much of the customer journey is firmly online. Consumers are browsing to search and discover items, as well as decide how they want their orders fulfilled, whether in store, curbside, or via delivery.

**Figure 1: E-Commerce Volume Surged by 37%**



Nov 2020, Digital Commerce 360. US ecommerce sales jump 37% in Q3. <https://www.digitalcommerce360.com/article/quarterly-online-sales/>

The customer expects a seamless path to purchase and fulfillment within one to two hours. Long-standing notions like right product, right place, right time have shifted (Figure 2). Supply chains are expected to handle disruption across almost every aspect of structure and performance. The “future store” is happening now. Smart autonomous systems will be required to deploy stores as fulfillment hubs. In order to create a sophisticated orchestration of inventory that drives speed, convenience, safety, and profitability, retailers need to invest in IoT technologies like sensors and robotics and must increase their analytics capabilities.

**Figure 2: Omnichannel Complexity Is on the Rise**

	Pre-COVID-19	Post-COVID-19
Right time	Days	Within hours
Right place	DCs	Consumers (stores becoming DCs)
Right price	Important	Greater willingness to pay for convenience/speed
Right product	Limited assortment in bulk quantities optimized for large-scale logistics	Endless aisle, late-stage configuration, and a customer “n” of 1
Right quantity	Pallets	Eaches
Right customer	Primarily B2B	D2C
Right condition	Important	Perfect; no tolerance

Sep 2020, Logistics Management. 29th Annual Masters of Logistics Survey: Are we ready to change? [https://www.logisticsmgmt.com/article/29th\\_annual\\_masters\\_of\\_logistics\\_survey\\_are\\_we\\_ready\\_to\\_change](https://www.logisticsmgmt.com/article/29th_annual_masters_of_logistics_survey_are_we_ready_to_change)

Lastly, visibility became the number one topic of interest among retailers struggling with omnichannel demands (Figure 3). Visibility is a prerequisite to having high levels of on-shelf (physical and digital) availability. High on-shelf availability in turn prevents brand or retailer switching. Access to real-time in-store inventory online is now table stakes. Gaps in product or inventory information and location inaccuracies slow down fulfillment time, reduce consumer trust, and erode margin. Standards can help improve visibility and data quality, which in turn leads to a happy customer.

These accelerated retail shifts have exposed challenges for the retail industry that need to be understood before going further.

**Figure 3: Top-Ranked Technologies—By Retailers**

	2020	2019	2018
Supply chain visibility	1	NR	NR
Predictive analytics	2	1	1
Artificial intelligence	3	4	4

Sep 2020, Logistics Management. 29th Annual Masters of Logistics Survey: Are we ready to change? [https://www.logisticsmgmt.com/article/29th\\_annual\\_masters\\_of\\_logistics\\_survey\\_are\\_we\\_ready\\_to\\_change](https://www.logisticsmgmt.com/article/29th_annual_masters_of_logistics_survey_are_we_ready_to_change)

## Top Challenges

Retail is being disrupted from many directions: wild fluctuations in demand and supply; constantly evolving consumer expectations; and increased reliance on product data to satisfy the need for valuable analytics. Add to these massive shifts the need for real-time inventory position insight at retailers—and then expectations for fast and flawless fulfillment—and you can understand why *Bain & Company* lists the top two challenges for retailers today as inventory visibility and optimized fulfillment.

- **Inventory visibility:** Inventory is being consumed by all channels—so accuracy in stock positions and available “to promise” inventory is a key advantage for retailers who control inventory electronically. Having real-time inventory data when allocating for each order can create a delightful customer experience. Conversely, inaccuracy can mean dismal performance in the eyes of your customer. Manual, paper-based inventory control systems result in misplaced product, phantom inventory, and count corrections/shrink. Misportrayed inventory information also bleeds back to brands—who may experience wild fluctuations in order volumes—further disrupting their ability to plan production. Safety stock anywhere is a costly compensation for these problems—reducing cash flow and further misleading true supply-and-demand signals. At the foundation of any electronic inventory and allocation process is the precise identification of items, exact location positions, and chain-of-custody information that allow orders to be distributed to in-stock inventory locations. These all require products to be identified and managed throughout their life cycle and the supply chain using common interoperable standards.

- **Optimized fulfillment:** As the final step in the order cycle, consumers must experience the order assembly (pick and pack), order completion (release), and fulfillment (in store/curbside/delivery) in a well-executed and timely manner. The longer a consumer goes without updates and insights to their order or if the order is changed from its original form—the higher the risk for dissatisfaction, cancellations, or incurring additional charges. A typical fulfillment process costs 2-3% of the order value. With margins already under pressure, any increase in these costs can erode profitability quickly. Inventory that is visible to all supply chain stakeholders—and that can be relied on with confidence—improves all subsequent fulfillment processes.

## Path to Success

Achieving inventory visibility and optimized fulfillment may seem elusive—however there are some practical steps brands and retailers can take to leverage the foundation of unique identification for improved efficiencies, higher customer satisfaction, and increased margins.

- **Go beyond the U.P.C.:** According to *VDC/GS1 US research*, inventory management is a top reason for brands and retailers to move beyond the traditional linear U.P.C. and into 2D barcodes and radio-frequency identification (RFID). These machine-readable data carriers have capacity for more precise identity and are able to carry batch/lot or serial number information in the code. They can support inventory-related attributes, for example freshness dates, that enable automating inventory processes such as expiry management, recall, and stock rotation. These data carriers are also core components for other business processes related to location precision, inventory allocation, and order accuracy.

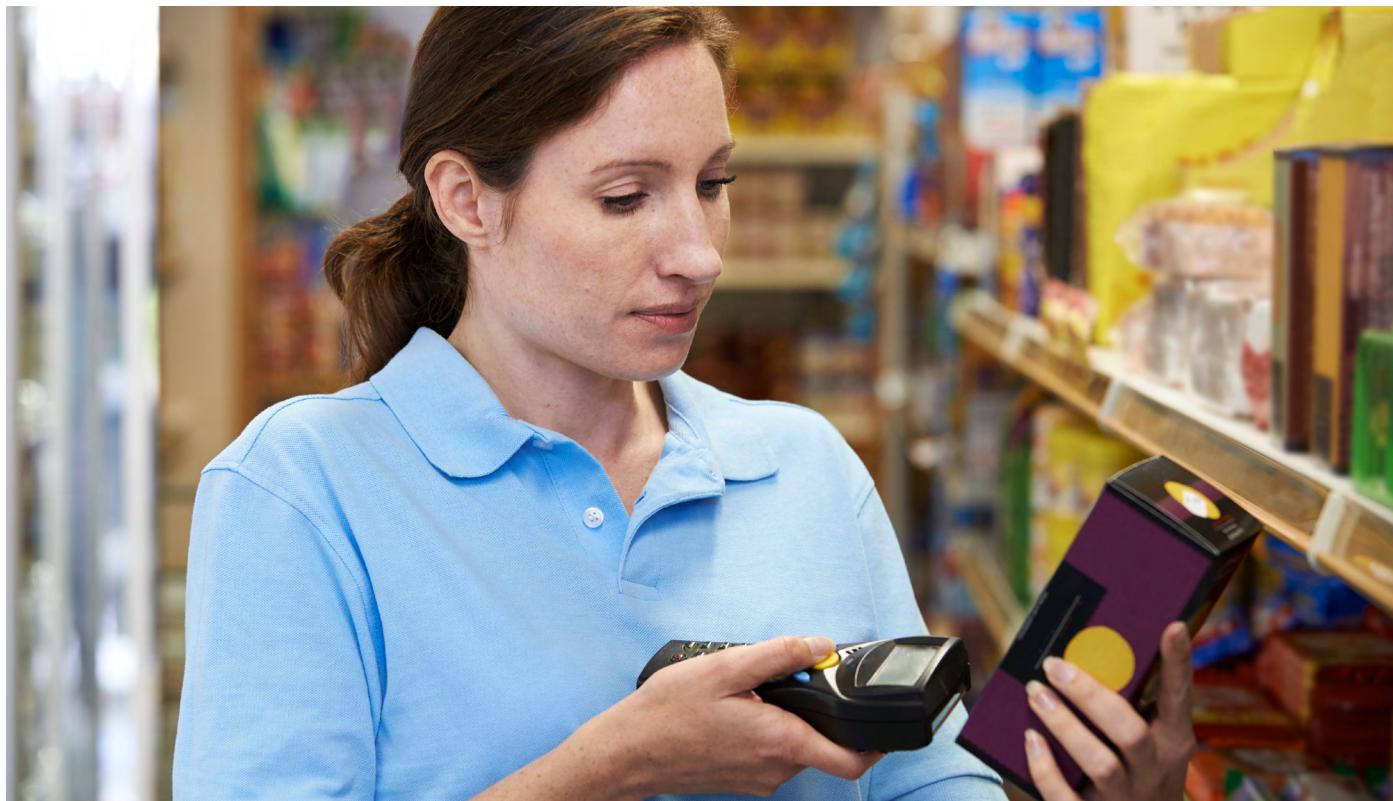
\* In this publication, the letters “U.P.C.” are used solely as an abbreviation for the “Universal Product Code,” which is a product identification system. They do not refer to the UPC, which is a federally registered certification mark of the International Association of Plumbing and Mechanical Officials (IAPMO) to certify compliance with a Uniform Plumbing Code as authorized by IAPMO.

## Autonomous Retail

- **Flexible fulfillment:** The surge in digital orders—combined with traditional brick-and-mortar demand—has increased fulfillment complexity. A retailer must start with real-time inventory visibility—in order to balance in-store shopping, pickup, and digital orders so that inventory is not over committed. With more stores evolving to also be digital fulfillment hubs, further consideration for inventory sequestering vs. dark stores vs. micro-fulfillment centers all must be factored into the allocation process. Technologies that utilize robotics to scan, pick, and assemble orders on the front end are the easiest solutions to automate and can make the investment in inventory allocation redesign and inventory deployment grow the fastest.

Cashierless checkout, store/warehouse cleaning, and robotic delivery are also margin-enhancing realities for many products and retailers. As with all elements of inventory management—relying on the precise identification already on a product will afford the retailer and the brand the best opportunity to quickly deploy solutions that meet both partner needs.

Let's move deeper into review of these two key areas of focus: inventory management and fulfillment.



# Inventory Management

Matching digital inventory to the physical and locating that inventory for fulfillment are primary concerns of retailers. Inventory visibility and data accuracy are the difference between a happy customer or a lost customer. These are key elements to forging consumer trust and loyalty.

## Key Challenge: Visibility

Visibility is knowing what you have (Global Trade Item Number® [GTIN®]), where you have it (Global Location Number [GLN]), and how much you have. Without this knowledge in real time, customers do not see real results and fulfillment is inaccurate and costly.

The pandemic created supply shortages in essentials, overloaded shipping channels, and increased complexity. Unprecedented demand shifts have overwhelmed demand planning systems and created ongoing stock-out problems. It also highlighted the inability to switch product between channels (e.g., food service to grocery).

- **Sporadic out-of-stock situations continue to be a problem:**  
“If I could change one thing about our business right now, it would be to have an even higher in-stock level.”  
– Walmart CEO 10/15/20
- **Inability to switch channels:** “Given the current foodservice environment, we will still have too many foodservice chickens.”  
– Sanderson Farms CEO 4/21/20
- **The need to move inventory differently:** New fulfillment capabilities and distribution models were needed to deal with the surge of e-commerce orders and safety concerns. “As we’ve navigated the pandemic, that focus has evolved to ensure we’re creating the safest place for our guests to shop.”  
– Target CEO 10/22/20

### Lack of end-to-end visibility creates delays in pick and ship times, inaccurate fulfillment, and retailer switching.

**Delays:** A lack of real-time inventory data caused delays in shipping and fulfillment, with retailers not knowing how much inventory they had, where it was located, and when it had sold out.

**Inaccurate fulfillment:** Poor data quality caused inaccurate fulfillment as digital inventory levels in the system did not match the physical reality, either on shelves or in the warehouse.

**Retailer switching:** The combination of product delays, lack of correct information, and general confusion caused large-scale retailer switching as retailers were unable to share accurate product data with or meet the expectations of their customers.

**Slow activation of new suppliers:** If there was shortage from a vendor, there was an inability to quickly activate a new supplier to compensate.

## Path to Success: Precise Identity

Adding more precise identity, such as batch/lot or serial number, alongside a GTIN in a machine-readable format is essential to increasing inventory accuracy. This enables more automated real-time use, at a more granular level, throughout the supply chain. To realize the benefits, this level of granularity must be encoded in high-capacity data carriers like 2D barcodes and/or RFID. When paired with a GLN, efficiencies can be gained for visibility to more accurate product availability, which is required to ensure accurate and on-time fulfillment. With GS1 Standards and technology in place, you can achieve higher data quality (the “what” and “where”) for better inventory control and more accurate visibility. Depending on demand signals, orders can be pushed forward or pulled back, and transit times can be sped up or slowed down.

1

### Pick the Level of Identification You Need

It all starts with a GTIN. Brands must first choose the type of identification needed to support both brand and retailer use cases. This paper focuses on unique product identification—the GTIN—and the importance for brands to consider adding additional precision to that GTIN to enhance or enable use cases throughout their supply chain:

- Batch/lot
- Freshness dates
- Serial number

In addition to GTIN, brands and retailers should utilize GLNs to identify locations such as manufacturing plants, warehouses, fulfillment centers, stores, slots, shelves, etc., throughout the supply chain.

## 2 Pick the Best Data Carrier

Once the item has been assigned a unique identity, brands must then choose the right data carrier.

### 1D Barcodes (U.P.C., GS1 DataBar®)

#### Benefits

POS scan for price lookup and class-level inventory

#### Constraints

- Lacks the capacity to encode more precise identification attributes
- Hinders autonomous system management of improved inventory tracking as well as freshness/recall management

### 2D Barcodes (QR, Data Matrix, GS1 DataMatrix)

#### Benefits

- Capacity to encode precise identification attributes
- Seamless consumer item engagement through web-enablement
- Supports multiple use cases with a single barcode

### RFID

#### Benefits

- Non-line-of-sight scan offering more accurate inventory at high-speed read rates
- Helps reduce the need for markdowns and stray excess inventory pieces, reducing the need for safety stock

### Other Data Carriers (Digital Watermarks, Image Recognition, Novel Encodable Data Carriers)

#### Benefits

Helps fill in functional gaps or overcome the limitations of current optically driven data carriers that may enhance a consumer's experience

#### Differentiator

Uses real-time shelf data for increased accuracy rather than POS data, which lags and can be inaccurate

## 3 Think About Priority Use Cases

- **First-In, First-Out (FIFO):** Promotes freshness and reduces waste
- **Pricing/Expiration management:** Automated markdowns and promotion management
- **Predictive analytics:** Ensure point-in-time availability for fulfillment
- **Consumer engagement:** Product origin, ingredients, allergens, recipes, loyalty tie-ins

## 4 Read With In-Store Available Technologies

### Smart shelves

#### Benefits

- Smart shelves can capture live video feeds and stills from on-shelf cameras
- Depth camera—Inventory estimation of shelf availability
- Alert staff for out of stocks, phantom inventory, wrong price, etc.
- Answer questions like “What items are out of stock?” or “Is there 100% planogram compliance?”

### Sensors

#### Benefits

- Sensors can enhance customer experience, reduce costs, drive growth, and improve performance
- IoT sensors are being used to monitor goods throughout the supply chain. Tracking systems report valuable data such as location, temperature, humidity, and insights into quality control and traceability. Real-time data from IoT sensors protects perishable goods, ensures optimal freshness, and reduces waste.

\* In this publication, the letters “U.P.C.” are used solely as an abbreviation for the “Universal Product Code,” which is a product identification system. They do not refer to the UPC, which is a federally registered certification mark of the International Association of Plumbing and Mechanical Officials (IAPMO) to certify compliance with a Uniform Plumbing Code as authorized by IAPMO.

## Drones

### Benefits

Drones can read 1D and 2D barcodes as well as RFID tags to take stock of physical inventory in Distribution Centers (DCs) and stores—for product, location, and quality assurance data (shelves, floors, walls for location orientation) ([Example ▶](#)).

- Smaller items and boxes can be autonomously moved around DCs, reducing the need for conveyor belts or forklifts.
- Larger Unmanned Aerial Vehicles (UAVs) can ship inventory between manufacturing facilities and DCs to expedite order fulfillment.



## Robotics and AI

Autonomous mobile robots can augment the shelf scan process. They can alert employees and even automate certain solutions

### Use case examples:

- Product is in the wrong location
- Product is not in stock
- Product is in stock, but not on shelf
- Direct store delivery of items
- Pricing is wrong
- Promotional price is different or promo tag is obsolete
- Location of repeated shrinkage or planogram non-compliance
- **Profitability opportunity:** \$X profit/sq foot → Expand display area
- **Double-function robots:** Combine floor scrubbing and shelf scanning capabilities
  - Sam's Club and Schnucks have confirmed rollouts across their stores in October 2020<sup>2</sup>

<sup>2</sup>Oct 2020, VentureBeat. Sam's Club expands autonomous floor-sweeping robots to all U.S. stores. <https://venturebeat.com/2020/10/21/sams-club-expands-autonomous-floor-sweeping-robots-to-all-u-s-stores/>

## Best Practice

All in all, greater visibility leads to greater accuracy. The vision is to be able to record any time an item is moved to facilitate automation, monitoring, and corrective actions as much as possible without human intervention. Standards that utilize GTIN with more precise identity for unique product identification, GLN for location identification, and technology like microfulfillment, 2D barcodes/RFID, drones, and computer vision are required to work together to achieve better accuracy.



# Fulfillment

Inventory management is the key to on-time and accurate fulfillment that is profitable. Let's take a deeper look at profitability challenges and ways to overcome them.

## Key Challenge: Profitability

At the start of the pandemic, delivery became the primary fulfillment choice of consumers at a great loss in profitability to retailers. However, investments that have pulled customers back to the store (faster fulfillment via automation, in-store discounts and experience, personalization via mobile app, etc.)

have significantly improved margin. Before we see how much margins can improve, let's first explore the pros and cons of customer fulfillment options from the retailer perspective.

**Figure 5: Rankings (Least to Most Profitable Forms of Fulfillment)**



Oct 2020, *The New York Times*. *Customers Still Like to Shop in Person, Even if They Get Only to the Curb.* <https://www.nytimes.com/2020/10/09/business/retailers-curbside-pickup.html>

## Path to Success: Flexible Fulfillment

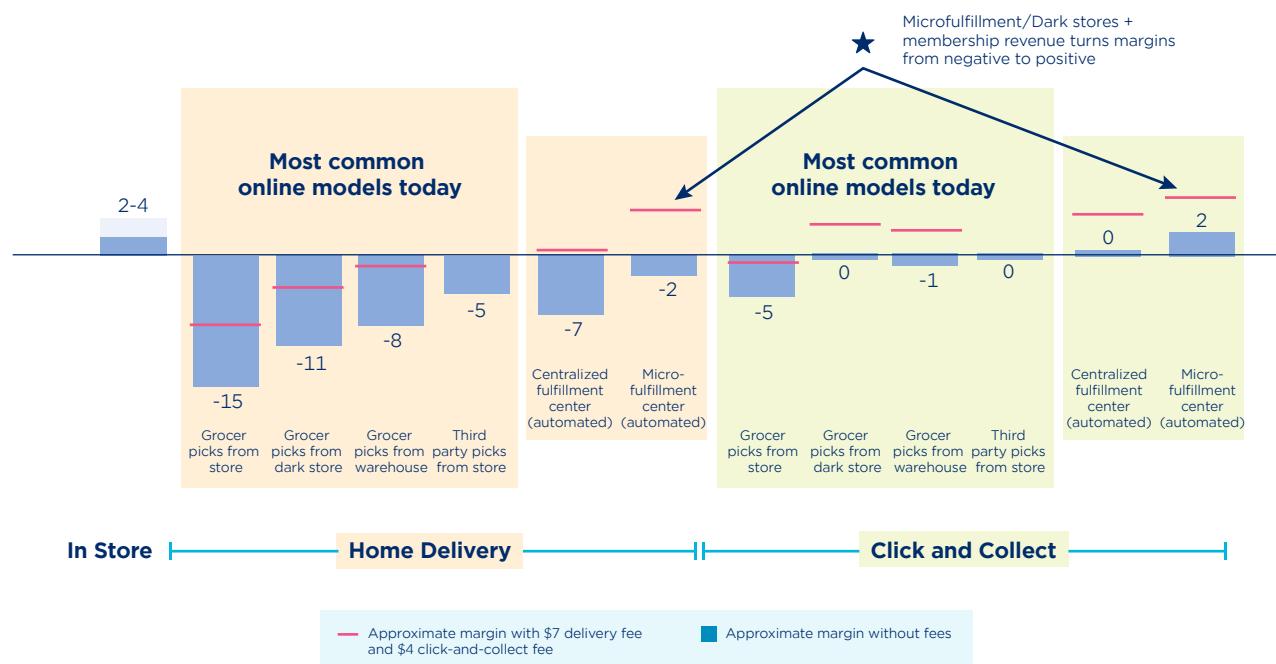
### 1. Order Assembly

#### Microfulfillment (Back of Store) & Dark Stores (Non-Public, for Online Orders)

Companies are working to get closer to customers and keep costs down by turning to smaller automated fulfillment sites. There are two varieties: “Microfulfillment” centers (MFCs) in the back of stores that service both online and in-store orders, and fully automated stores (dark stores) in urban areas that only fulfill online orders.

Grocery net margins are typically between 2-4%. When you layer on pick, pack, and deliver without removing costs or adding fees, margins quickly turn negative. However, if you invest in microfulfillment or dark stores, margins turn positive (see below).

**Figure 6: Grocery Margins (% Net)—By Channel and Model**



Jul 2020, Bain & Company. *How to Ramp Up Online Grocery—without Breaking the Bank*. <https://www.bain.com/insights/how-to-ramp-up-online-grocery-without-breaking-the-bank/>

### Success Stories

- **Kroger/Ocado:** This partnership has resulted in the creation of several dark stores up to 300K square feet in size. Dark stores allow Ocado to get “groceries into a customer’s kitchen for less operating costs than competitors can manage a store.”

– Ocado, CEO, Tim Steiner

- **Wakefern/Takeoff:** “With a \$3 million investment and a retailer being able to offer 95% of what their customers are buying and fulfill it 10 times as fast as they can pick in the store, the economics are really good.”

– Takeoff Technologies, COO, Laura Scott

## 2. Customer Possession

### Click and Collect (Buy Online, Pick Up in Store (BOPIS)/Curbside)

It is said that necessity is the mother of all invention. Safety became the key word when taking a trip to the store. Social distancing and explosive digital growth necessitated a re-imagination of the role of the store. It is now a fulfillment hub, where the customer experience begins with a click from home or tap of the phone and often ends without setting foot in the store. To quantify the pace of this change, 44% of retailers surveyed (8/20) offered curbside pickup, compared to 7% at the end of 2019.<sup>3</sup> While several Tier 1 (\$1B+) retailers had BOPIS prior to 2020, virtually none had curbside pickup, which quickly became a popular safety innovation, eclipsing BOPIS.

BOPIS and curbside allow big-box retailers to convert their stores into mini fulfillment centers, while avoiding negative ship-to-home margins. However, optimizing the experience for customers is key. To satisfy consumer demand, retailers need to leverage standards with technology to create a zero wait, zero surprise experience driven by integrated order management systems and connected IoT devices.

Profitability benefits of click and collect vs. delivery:

- Visibility into the chain of custody and fulfillment flow is higher than delivery
- Potential for addition to basket (BOPIS only)
- Lower cost—shoppers take on the last mile

#### Click and Collect - Retailer Highlights<sup>4</sup>

- **Nordstrom:** “Order pickup is our most profitable transaction.”  
– President, Erik Nordstrom
- **Best Buy:** 40% of online sales are coming from BOPIS
- **Walgreens:** “Drive-thru customers are getting a wider variety of items (for pickup), including cans of soup and cleaning products.”  
– VP of Digital Commerce, Stefanie Kruse

### Delivery (Last Mile)

Fulfillment from stores can support same-day delivery and optimize use of its inventory and assets. Standards help enable store fulfillment readiness for delivery. Because the item is fulfilled from the store, customers do not need to check for shipping updates, and the item may arrive in a store bag instead of a shipping box, saving on packaging.

3PL (third party logistics) solutions like FedEx are also looking to use retail stores as a launch point for last-mile delivery and partner with retailers on autonomous solutions.

- **Cargo sensors:** Scan barcodes as packages are loaded into vans and light up the shelf where the item should be placed. It makes for a faster loading process and removes the need to scan with handheld devices. Saving 1-10 minutes improves delivery/cost.
- **Autonomous robots:** Deliver on-demand, same-day small deliveries within a 3-5 mile radius. One example is a bot offered through a partnership with FedEx and a retailer or pharmacy, where it lives on-site and can be sent on deliveries at a moment's notice.
- **Drones:** Take off from stores and travel up to 6 miles per trip, lowering orders on a customer's steps or lawn from 80 feet in the air. In testing, various drone companies have successfully delivered groceries, household items, prescriptions, and COVID tests to consumers.

### Cashierless Checkout (Computer Vision)

- **Walk In/Out:** Cameras track when a consumer picks up an item or scans it with their mobile phone, reduces the inventory count (vs. relying on point-of-sale data), and charges their accounts as they leave the store. No human intervention or stops in the front of store are required.
- **Cameras:** Are used overhead (Standard Cognition, Grabango), in smart carts (Caper, Dash Cart), or via a mobile app (Sam's Club)
- **Analytics:** Can be captured to show dwell time and how customers evaluate brands, e.g., “In the month of February, customers spent an average of 40 seconds evaluating Brand X.”

In order to increase adoption of computer vision and other use cases in the supply chain, GS1 US® is working with brands and retailers to standardize identification, storage, and sharing of 3D files. [Reach out](#) to learn more.

<sup>3</sup>Aug 2020, Digital Commerce 360. Charts: How the coronavirus is changing ecommerce. <https://www.digitalcommerce360.com/2020/08/25/ecommerce-during-coronavirus-pandemic-in-charts/>

<sup>4</sup>May 2020, CNBC. ‘There’s no other option.’ Costco, Gap and other retailers sweeten online offerings, but it’s coming at a cost. <https://www.cnbc.com/2020/05/18/retailers-are-rushing-to-get-online-but-that-brings-new-challenges.html>

## Best Practice

### Optimized fulfillment is a complex problem

To address it—and ultimately achieve optimum performance levels—two foundational operations are key. First, inventory must be identified and tracked in real time—allowing available-to-promise and allocation processes to execute against accurate inventory counts. Second, unique and precise identification must remain with an item throughout the supply chain. This supports a range of options for fulfillment, mapped and ready for deployment, to achieve consumer expectations while keeping costs to the lowest level possible. These operational tasks have two common elements to help ensure success: first, brands must create and maintain correct identification and data attribution for products that include batch/lot, serial number, or other embedded identifiers. Second, retailers should invest in business process designs and fulfillment technologies that leverage the precise identification for use in automated pick and pack, click and collect, cashierless checkout, and last mile delivery options.



# GS1 Standards

GS1 Standards are the foundation for inventory management, driving accurate and profitable fulfillment. Greater efficiency and business benefits can be achieved when standards are accompanied by emerging technologies. Below is a good, better, best continuum that supports these two critical areas required for success.

## Good (GTIN/GLN):

### **Brand Owners: Identify products with GTINs that have a “thin layer” of verifiable product information.**

- Reference **Verified by GS1 (VbG)** for key master data attributes that create trust and confidence in the products. The digital identity is thus connected to the physical identity for a consistent omnichannel experience.
- Consider **Global Data Synchronization Network (GDSN)** for master data synchronization with trading partners
- Reference **GS1 Global Data Model (GDM)** to help simplify and clarify data requirements to be shared. Good master data is a precursor to benefits promised by technology.

### **Brand owners and retailers:**

- Assign GLNs to identify manufacturing plants, warehouses, fulfillment centers, stores, slots, shelves, and bins
- Consider **GS1 US Data Hub Product and Location** services to help manage and share both product and location identification

## Better (2D/RFID/GS1 Digital Link)

### **Brand Owners: Add precise identity**

- Embed batch/lot and/or serial number data into 2D or RFID machine-readable data carriers
- Utilize **GS1 Digital Link** (common data structure for physical & digital) to:
  - Web-enable barcodes for consumer engagement
  - Share brand-authorized data
  - Help enable enhanced analytics, authenticity verification, cycle counting, expiry management, FIFO, etc.

## Best (GS1 Digital Link/EPCIS): Extend use of GS1 Digital Link; add visibility event data

### **Extend the use of GS1 Digital Link for additional business process efficiencies**

- Associates can scan 2D barcodes with GS1 Digital Link for real-time data access
  - Improve inventory management with use cases such as: reorders, expiry management, targeted recalls, promotions, returns, safety
- Brands can “own their story” with targeted recall management
  - Add Electronic Product Code Information Services (EPCIS) for traceability
- Answers the “what, where, when, and why” in the supply chain

## Best Practice

Standards and technology can be implemented via a roadmap of “good, better, best.” Collaboration with trading partners is critical to ensure alignment throughout the journey.

<b>Figure 7: The Standards Journey: “Good, Better, Best”</b>			
<b>Standards + Tech</b>	<b>Good</b>	<b>Better*</b>	<b>Best*</b>
Identify Standards	GTIN + GLN	6 Basic Item Attributes (VbG)	Precise identification attributes: Batch/Lot Number, Serial Number, GS1 Digital Link
Capture Standards	1D barcodes	2D barcodes	RFID
Sharing Standards	Global Data Model (GDM)	Global Data Synchronization Network (GDSN)	Electronic Product Code Information Services (EPCIS)
Fulfillment Tech	BOPIS/Curbside	POS Optical Scanners, MFCs	Dark Stores, Computer Vision (CV)
Inventory Tech	2D barcodes + RFID	Robotics	Shelf Scanning (CV/Robotics), Predictive Analytics
Tech Timeline	Now-1 year	Now-3 years	Now-5 years

\*Note: “Better” includes “Good.” “Best” includes “Better” and “Good.”

# Summary

This whitepaper highlights the benefits that precise identity, leveraging the use of GS1 Standards, and implementing emerging technology offer for improved inventory visibility and accurate, on-time fulfillment. As companies scale digital commerce with autonomous systems, a smarter supply chain is developing, one that will be agile enough to adapt to the erratic demand shifts created by disruptive events.

GS1 Standards are foundational because they are technology agnostic. By investing in global standards, whether you stay with existing systems or move to autonomous technologies, your ability to quickly adapt as trends change will improve. For example, today GTIN is supported in current technologies like 1D barcodes, 2D barcodes, RFID, as well as emerging technologies like computer vision, IoT, etc.

## Call to Action

### Retailers

**Work with brands to add 2D barcodes and/or RFID** data carriers on packaging embedded with more precise identity, e.g., batch/lot number or serialization, to improve inventory visibility and fulfillment.

- Consider starting with the store brand (if any), and reference your success to convince brand owners to follow suit
- Consider using RFID for faster cycle counting and inventory management where appropriate for product type

**Upgrade to optical scanners** at POS to read 2D barcodes, and backend systems to ingest more than just GTIN data. Optical scanners allow retailers to extract more than just the GTIN for price lookup. This additional data can improve expiry management, promotional pricing, recalls, and returns. Retailers surveyed by VDC Research indicated that improved inventory control is a key driver for the upgrade. Review the GS1 US Getting Started Guide for Advanced Data Carriers at POS on the [Future of Retail page](#).

**Autonomous systems**, e.g., cashierless checkout, real-time inventory monitoring at shelf, robotic inventory scans, or drones should be considered for pilot opportunities. Microfulfillment centers and dark stores [create positive margin](#) vs. other fulfillment models because they take up less space and need fewer people to serve more customers.

### Brands

**Embed precise identity (batch/lot or serialization)** into products in a machine-readable format (2D barcodes/RID) for better customer engagement and inventory management to help foster trust and loyalty.

**Utilize GS1 Digital Link** to web-enable 2D data carriers:

- Protect and expand the investments you've already made into GS1 Standards
- For more information, visit [GS1 Digital Link](#)
- For more information, visit [Powering the Future of Retail \(Beyond the U.P.C.\)](#)

### All

**Determine priority concerns** in your company related to fulfillment and inventory visibility to identify the best technology and standards solutions.

**Reference** [The GS1 Standards Journey](#)

**Contact** [GS1 Advisory Services](#), where you can find help for:

- GS1 Standards fundamentals
- GTIN management standards
- Data quality assessment and data governance
- Business process assessments
- GS1 Standards for traceability (EPCIS)

**Participate in a pilot:** Join a [GS1 US Innovation Pilot](#) as we explore how to maximize output of next-generation technologies paired with GS1 Standards.

**Create a case study:** Work with GS1 US to publish a case study to showcase how you have leveraged visibility to improve fulfillment and profitability.

\* In this publication, the letters "U.P.C." are used solely as an abbreviation for the "Universal Product Code," which is a product identification system. They do not refer to the UPC, which is a federally registered certification mark of the International Association of Plumbing and Mechanical Officials (IAPMO) to certify compliance with a Uniform Plumbing Code as authorized by IAPMO.

# Appendix

## Glossary



### Identify

**Globally unique identification numbers**

**GTIN (Global Trade Item Number)**: can be used by a company to uniquely identify all of its trade items. GS1 defines trade items as products or services that are priced, ordered, or invoiced at any point in the supply chain.

**GLN (Global Location Number)**: The GLN is encoded in either a barcode or RFID tag to automatically identify locations like storage places in a warehouse, the destination of a pallet, or the origin of a product. The GLN extension component can be added to a GLN to provide more precision in recording and sharing of supply chain events. For example, an extension component may identify sub-locations such as storage bins, shelves, dock doors, scan, and read points.

**Verified by GS1 (VbG)**: Verified by GS1 can help organizations answer the question: "Is this the product that I think it is?" It is a service that checks on the unique product identifier and six attributes to every product information is complete and accurate. It enables consistent data sharing, trust, and efficiency.

**Global Data Model (GDM)**: The GS1 Global Data Model helps you leverage your product content for a seamless shopping experience across every channel. By simplifying and harmonizing the exchange of product data around the world, the GS1 Global Data Model increases operational efficiency for brand owners and retailers and improves data accuracy and completeness for consumers.



### Capture

**Automatic data capture**

**1D barcodes**: Symbols that can be scanned electronically using laser or camera-based systems. They are used to encode information such as product numbers, serial numbers, and batch numbers.

**2D barcodes**: Create consumer engagement and connection to extended information about products. They enable supply chain, POS, and applications on smart devices.

**Radio Frequency Identification (RFID)**: When unique Electronic Product Codes (EPCs) are encoded onto individual RFID tags, radio waves can be used to capture the unique identifiers at extremely high rates and at distances more than 10 meters, without line-of-sight contact. These characteristics of RFID can be leveraged to boost supply chain visibility and increase inventory accuracy.



### Share

**Exchange of business-critical information**

**GDSN (Global Data Synchronization Network)** is an interconnected network of interoperable data pools governed by GS1 Standards.

**GS1 Digital Link**: Extends the power and flexibility of GS1 identifiers by making them part of the web. This means that GS1 identifiers, such as the GTIN, are now a gateway to consumer information that strengthens brand loyalty and improves traceability information and business partner APIs, etc.

**EPCIS (Electronic Product Code Information Services)**:

A standard interface for sharing information about the movement and status of goods. It enables capture of visibility event data in the supply chain and supports query capabilities about those physical events in a structured format. EPCIS makes end-to-end supply chain visibility possible. Trading partners can leverage information on the location and history of individual items as they move along the supply chain, thereby increasing safety, security, accuracy, efficiency, and visibility.

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GS1 US recommends that any organization developing an implementation designed to be in conformance with the GS1 Digital Link Specification should consult with their own counsel to determine the compliance of such an implementation with any relevant intellectual property or other rights of third parties.

\*If applicable

## About GS1

GS1® is a neutral, not-for-profit, global organization that develops and maintains the most widely used supply chain standards system in the world. GS1 Standards improve the efficiency, safety, and visibility of supply chains across multiple sectors. With local Member Organizations in over 110 countries, GS1 engages with communities of trading partners, industry organizations, governments, and technology providers to understand and respond to their business needs through the adoption and implementation of global standards. GS1 is driven by over a million user companies, which execute more than six billion transactions daily in 150 countries using GS1 Standards.

## About GS1 US

GS1 US®, a member of GS1 global, is a not-for-profit information standards organization that facilitates industry collaboration to help improve supply chain visibility and efficiency through the use of GS1 Standards, the most widely used supply chain standards system in the world. Nearly 300,000 businesses in 25 industries rely on GS1 US for trading partner collaboration that optimizes their supply chains and drives cost performance and revenue growth while also enabling regulatory compliance. They achieve these benefits through solutions based on GS1 global unique numbering and identification systems, barcodes, Electronic Product Code (EPC®)-based RFID, data synchronization, and electronic information exchange. GS1 US also manages the United Nations Standard Products and Services Code® (UNSPSC®).

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