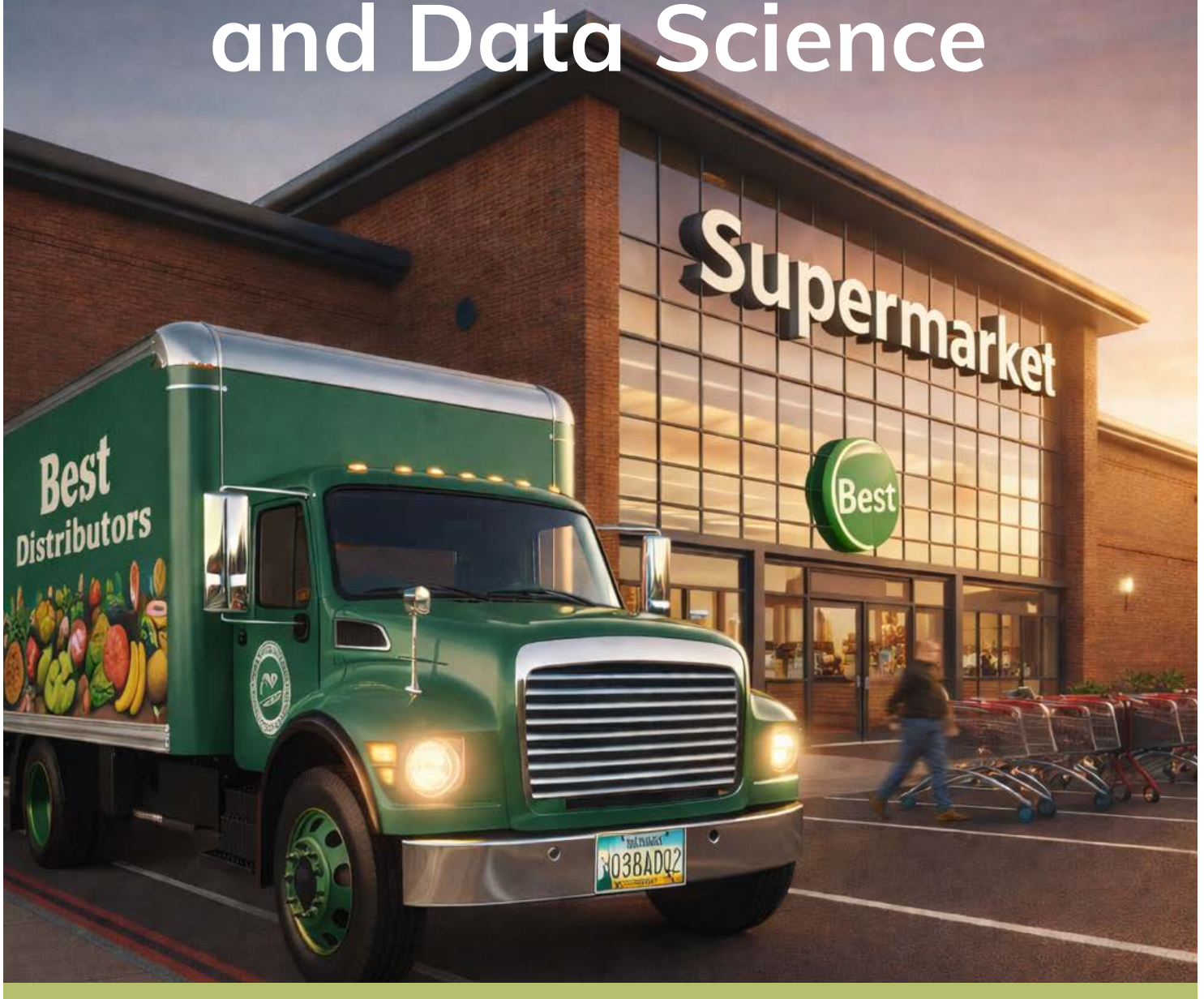


# Solving Final Mile Traceability with Collaboration and Data Science



The FDA's *Final Rule on Requirements for Additional Traceability Records for Certain Foods*, commonly known as FSMA 204, establishes new traceability recordkeeping requirements for how food supply chain partners capture, store, and share traceability data. Its goal is simple but ambitious: protect public health by modernizing traceability so that foods implicated in an outbreak can be rapidly identified and removed from the marketplace.

While supply chain partners already share some traceability information in their business transactions, FSMA 204 introduces two additional, critical variables:

- ▶ 1. the Traceability Lot Code (TLC) and
- ▶ 2. the TLC Source.

The rule also requires that this information be shared electronically and carried through the *final mile*, to the point-of-service or sale. This has triggered a pivotal question in the industry: *How do we achieve lot-level tracking without the burden of scanning every case?*



## The Challenge

For distribution centers (DCs) tasked with efficiently moving vast volumes of perishable and non-perishable foods, final-mile lot-level tracking is not a trivial lift. Several systematic limitations make it difficult:

1. Inconsistent recording of TLC and TLC Source for individual cases on pallets – especially mixed pallets.
2. Warehouse management systems (WMS) typically optimized for efficient inventory management, not lot-level tracking.
3. Operational realities such as lumping, mixed pallets, and replenishment and selection practices that undermine lot-level precision.

GS1 standards provide well-validated tools<sup>1,2</sup> – GS1-128 case labels, Advanced Ship Notices (ASNs), and SSCC-18 pallet labels – that enable sharing accurate case-level TLC and TLC Source information. When suppliers follow these standards, DCs can reliably identify TLCs entering the warehouse on a given date and time. However, they still lack the infrastructure, workforce, and time to know precisely when a TLC leaves the warehouse and where it goes.

Pilot studies, cost analyses, and industry working groups have consistently found that scanning every outbound case label to capture TLC information to the final mile is not economically feasible.

Upgrading hardware-based systems (e.g., RFID, IoT) introduces high capital and maintenance costs and takes time to implement. And the regulatory enforcement delay has made organizations cautious about premature investment.

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1 [GS1 US: Retail Grocery and Foodservice Application of GS1 System of Standards to Support FSMA 204](#) (March 12, 2024)

2 GS1 US: <https://www.gs1us.org/content/dam/g1us/documents/industries-insights/by-industry/food/initiative/GS1-US-2D-Barcode-Overview-General-Distribution.pdf>



## A Different Approach: Introducing the Calculated Lot Code

Recognizing these realities, iFoodDS and partners across the fresh-food supply chain explored whether analytical methods could bridge the gap. The result is a novel alternative: calculate, rather than physically capture, the TLCs in each outbound order. This analytical method was designed to:

- ✓ Work with the systems and workflows DCs already use.
- ✓ Provide accurate, low-cost, lot-level traceability without scanning every case.
- ✓ Create and store shipping records in the iFoodDS traceability platform, Trace Exchange™, that can be shared forward to the final mile and exported during a records request.
- ✓ Support future investments in technology and practices that enable robust traceability systems.

Across the industry, this has sparked an important conversation about when algorithmic or probabilistic approaches are appropriate, and how they can complement physical traceability.



## Here's How it Works

The analytical method developed by iFoodDS, Lot Code Assist (LCA), is a traceability algorithm that augments a WMS to track inventory movements at the lot level, so that a TLC and TLC Source can be provided for each case or item shipped out.

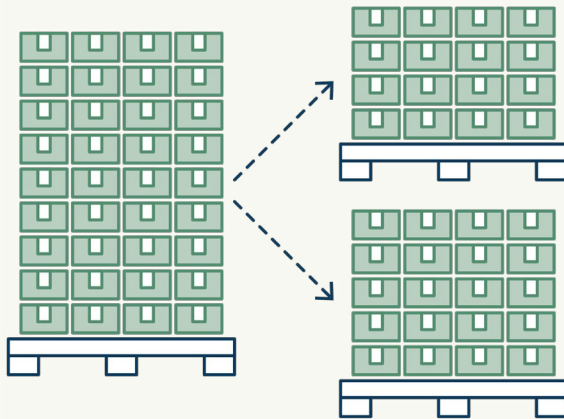
It transforms well-known operational complexities into data problems that can be solved with simulation modeling and probability theory rather than scanning every case as it is pulled from a pallet. This analytical approach determines what TLCs are present in a slot when a sales order is filled, how many cases per TLC were selected, and what is the likelihood that a sales order contains a specific TLC present in the slot.

## Operational Realities Framed as Data Problems

Distribution centers follow practices that make precise case-level tracking difficult. These include:

### Lumping:

breaking down inbound pallets into multiple smaller pallets



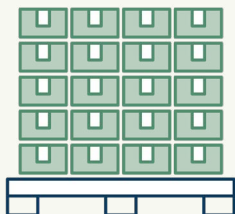
### Mixed Pallets:

multiple lot codes intermingled across cases.

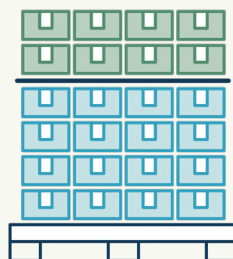


**These practices make case-level tracking challenging, but they also create patterns that can be modeled.**

### Replenishment and Selection



**Pick-to-zero:**  
one pallet per slot must be fully emptied before replenishment.



**Threshold:**  
a pallet is emptied to a certain threshold, then a new pallet is added to avoid an empty slot.



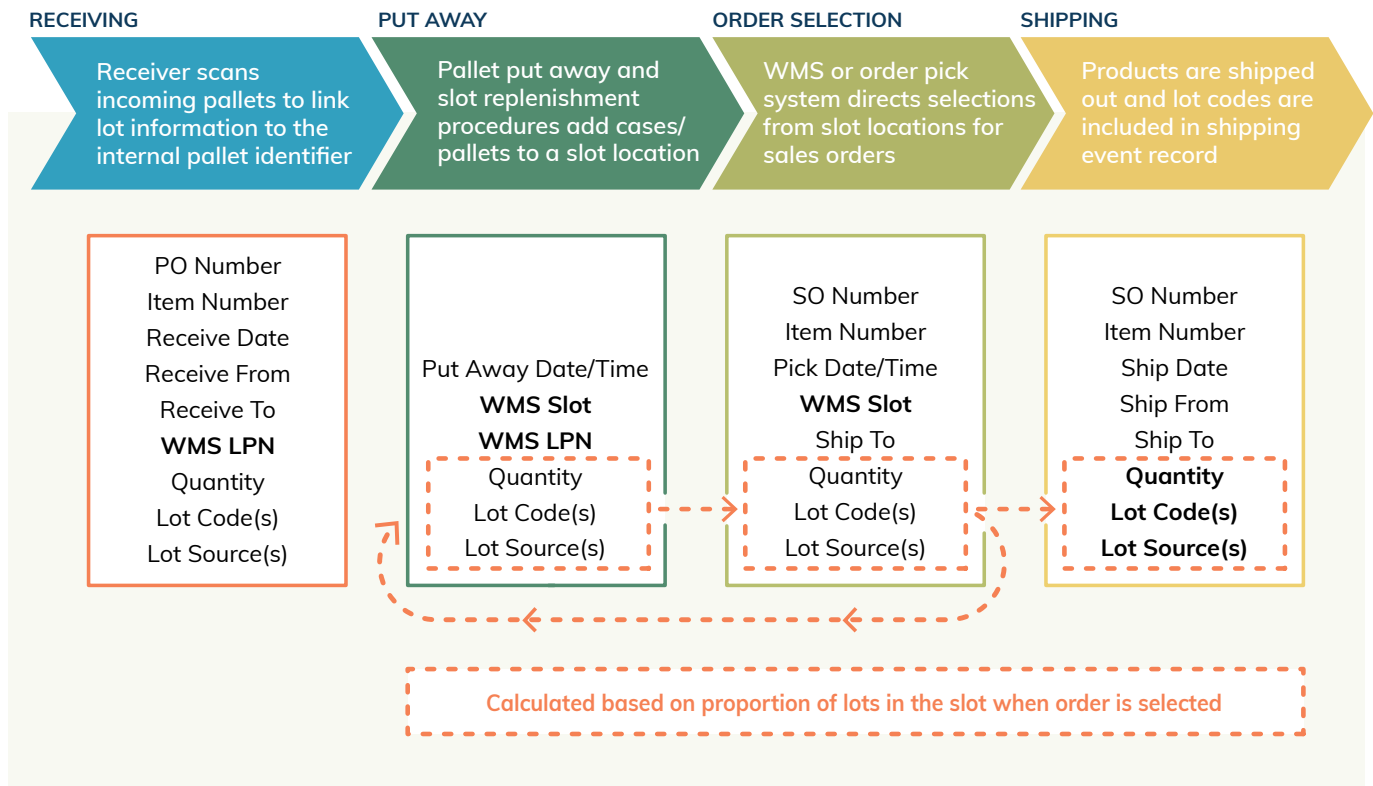
**Undermining:**  
selectors pulling cases within easiest reach, rather than top-down, in high-velocity operations.

As in all model-based systems, the accuracy and reliability of the results depend on accurate and reliable inputs.

Lot Code Assist relies on core inputs:

1. **Accurate receiving data:** TLCs and case quantities tied to uniquely identified pallets.
2. **WMS transaction data:** replenishment, movements, and selection events.
3. **Warehouse configuration:** pick slot types, slot locations, pallet configuration, and replenishment rules.

By combining these inputs, Lot Code Assist estimates the likelihood of TLCs leaving the distribution center in each outbound order.



# Outputs Designed for FSMA 204 Compliance

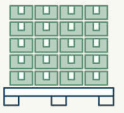
The outputs of Lot Code Assist are used to complete shipping records in iFoodDS Trace Exchange that can be shared forward in the supply chain and exported in an electronic sortable spreadsheet.

It is important to note that Lot Code Assist estimates both:

- the expected number of cases per TLC and
- the likelihood that at least one case from a specific TLC (present in the pick slot) was contained in an order shipped from a DC.

In many real-world DC scenarios, this is not only more accurate information than available from conventional approaches but is also sufficient to narrow down the scope of TLCs during an investigation.

## Lot Code Assist results for various inventory practices



Pick-to-zero

Ref Doc No.	Quantity*	Probability**	Product Description	Traceability Lot Code	TLC Source
618903	10 CS	100%	Iceberg Lettuce	GREEN	FFRN#1



Threshold + undermining

Ref Doc No.	Quantity*	Probability**	Product Description	Traceability Lot Code	TLC Source
618903	2 CS	87%	Iceberg Lettuce	GREEN	FFRN#1
618903	8 CS	100%	Iceberg Lettuce	BLUE	GLN#2



Pick-to-zero + mixed pallet

Ref Doc No.	Quantity*	Probability**	Product Description	Traceability Lot Code	TLC Source
618903	6 CS	100%	Iceberg Lettuce	GREEN	FFRN#1
618903	3 CS	97%	Iceberg Lettuce	BLUE	FFRN#1
618903	1 CS	75%	Iceberg Lettuce	YELLOW	FFRN#1

\*Quantity = estimated cases per TLC, rounded; \*\*Probability = likelihood ≥ 1 case per TLC, rounded



## The Future of Final Mile Traceability Compliance

Across working groups (IFPA and PFT), industry forums (e.g., FMI's Supply Chain Forum), and stakeholder roundtables, there is strong enthusiasm for analytical approaches that reduce reliance on manual scanning and avert costly investment in hardware-based systems (e.g., sensors, cameras, RFID, etc.). Large distributors and retailers increasingly view calculated or probabilistic traceability as a practical compromise that balances efficiency, cost and compliance.



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***FDA outbreak investigations depend on complete FSMA 204 data—especially Traceability Lot Codes delivered in Electronic Sortable Spreadsheets. Yet case-label scanning at foodservice distributors is not scalable today. iFoodDS Lot Code Assist enables FDA-ready data without adding labor pressure or consuming critical dock space.***

– Andy Kennedy, Chief Traceability Officer, iFoodDS



iFoodDS has engaged with FDA during the development of Lot Code Assist to understand its implications for traceback procedures and regulatory enforcement. These discussions revealed several important insights:

- FDA is open to varied tools and processes, including algorithmic methods.
- Additional data fields can be included in the electronic sortable spreadsheet.
- The probability of a TLC present at the final mile is informative when aggregating data during a traceback.
- FDA's most recent FSMA 204 FAQ updates explicitly acknowledge that various tools and processes (including algorithms) may be used to achieve compliance.
- The accuracy of KDEs will be refined and improved over time as systems evolve.<sup>3</sup>

This reinforces what many in the industry already understood: traceability accuracy is not static – it matures as technology, adoption, and data quality improve.

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<sup>3</sup> <https://www.fda.gov/food/food-safety-modernization-act-fsma/frequently-asked-questions-fsma-food-traceability-rule#TI10>

## Testing, Validation, and the Path Forward

As with all model-based systems, the quality of Lot Code Assist's outputs depends on the quality of its inputs. iFoodDS continues to refine minimum requirements, validate the approach in DCs, and quantify accuracy.

### Current Minimum Requirements

Minimum requirements for receiving are:

- Capturing TLC and TLC case quantities per pallet received and put away
- Reliable inventory data tied to pallet and slot movements

### Challenges Requiring Additional Study

Some scenarios strain deterministic and probabilistic methods alike:

- Split or item-level selections
- Returned products
- Inventory adjustments
- Unlabeled, mislabeled, or partially labeled inbound cases and pallets

A rigorous evaluation, using a statistically significant number of cases tracked, would enable measurement of the sensitivity and specificity of the algorithm, and acceptable error bounds. This would provide gold-standard comparisons to further refine the algorithm.

## Conclusion

Final-mile traceability compliance is both a scientific challenge and an operational one. While the industry continues to modernize infrastructure and adopt GS1 standards, analytical methods like Lot Code Assist offer a scalable, low-friction bridge between today's practices and tomorrow's fully digitized supply chain.

By blending collaboration, statistical modeling, and practical implementation, the industry can achieve FSMA 204 compliance without compromising operational efficiency, and build the foundation for stronger, more resilient traceability systems.

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**iFoodDS can help. [Schedule a consultation](#) with one of our traceability experts to learn how you can use Lot Code Assist to scale your operation.**

## About the Author



### Claire Zoellner, Ph.D.

Director of Data Science, iFoodDS

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Claire Zoellner is the Director of Data Science at iFoodDS, using her expertise in microbial contamination, simulation models, and risk assessment to develop and deliver pragmatic, science-based decision support tools for the food industry. Before iFoodDS, Claire held a Postdoctoral Research appointment at Cornell University, working on modeling tools to address the risk of Listeria contamination in frozen foods. Claire holds a B.S. in Food Science and Human Nutrition from the University of Illinois Urbana-Champaign and a Ph.D. in Food Science and Technology with minors in Epidemiology and Systems Engineering from Cornell University.