



GUIDE:

Demystifying IoT for Supply Chains

Learn the basics of what IoT is, why it works so well, and how it can be used to gain critical insights for your supply chain.

Gaining supply chain insights

Supply chains have always been, and will always be, extremely complex. No matter how much a company does to simplify, reduce, cut waste, and streamline, complexity will play a role. Even the journey to attain simplicity involves processes like a search for the best vendor, an analysis of tighter processes, and a system to clean up systems.

To add to this fact, change is inevitable and generates complexity in itself. As supply chains grow, whether that looks like added miles or a broader portfolio of products, the need for precision intensifies. In their article “How Platforming Builds a More Resilient Supply Chain”, Supply Chain Management Review comments that “Complexity is the Achilles heel of the supply chain and companies with complex product portfolios inherently have more potential points of failure throughout their networks.”¹

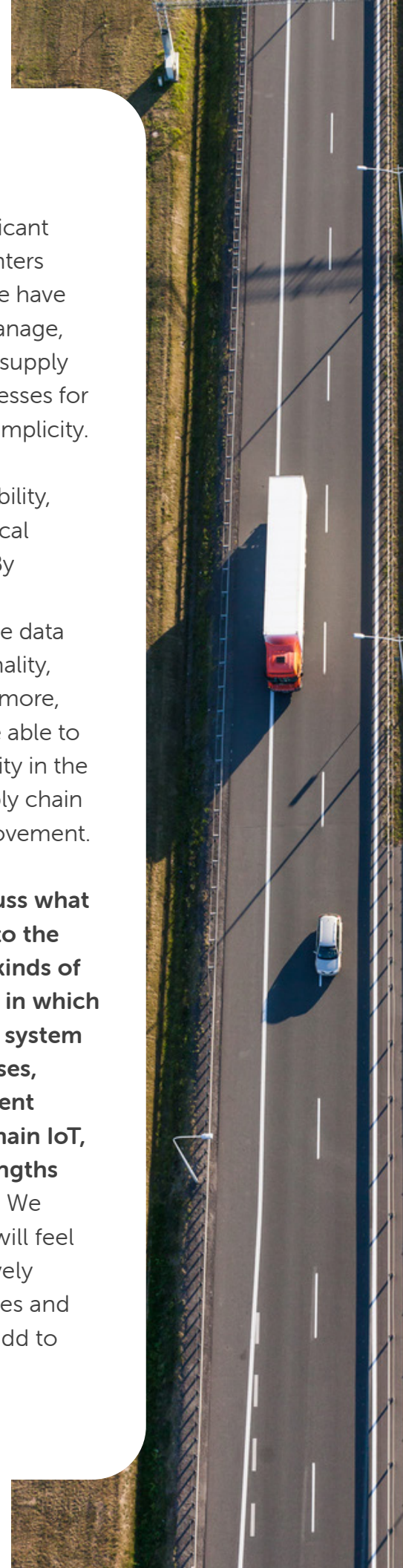
Helpful technology to facilitate change and growth

Fortunately, new tools have been developed to facilitate supply chain change and ease that transition. Automation, for example, is an exploding part of the industry and has enabled companies to

scale operations at a significant rate. Cloud-based data centers and cyber security software have ushered in the ability to manage, store, and protect data for supply chains and centralize processes for enhanced efficiency and simplicity.

Supply chain IoT, or traceability, is an important technological development in the field. By functioning as a means to collect and visualize precise data about movement, functionality, temperature, hygiene and more, supply chain managers are able to improve control and visibility in the inner workings of the supply chain and achieved overall improvement.

In this guide we will discuss what supply chain IoT is, go into the nuances of the different kinds of technology, outline ways in which a strong supply chain IoT system can improve your processes, and discuss several different applications for supply chain IoT, covering the various strengths and weaknesses of each. We hope that in the end you will feel less daunted by this relatively new system of technologies and consider the value it can add to your supply chain.



Introducing Supply Chain IoT

Supply Chain Brain defines IoT as “an ecosystem of interactions between devices, sensors, actuators, applications, data, analytics and networks, all communicating with one another.”² Supply chain IoT is simply that network of connections applied to supply chains. **This can help with inventory management, process flow management, utilization monitoring, condition monitoring, maintenance management, delivery monitoring, temperature monitoring, and more.**

Protecting the Cold Chain: Delivering Real-time Data and Generating Trust

Protecting the cold chain is just one example of the critical importance of improving tracking technology. Updates to CFR regulations have recently been generating some anxiety in a supply chain industry already pinned down by restrictions. Specifically, Section 204 of the FDA Food Safety Modernization Act² compels stricter management of the cold chain, requiring recorded data to prove that refrigerated and frozen goods are held to a steady temperature throughout the supply chain.

These updates are not unfounded, of course. *Food Logistics* reports that, “In 2023 alone, there have already been more than 40 food and beverage product recalls.”³ As long as consumer demand requires food to travel long distances, the process of ensuring that food is safe all the way to consumer refrigerators will be critically important.

In essence, supply chain IoT is a path to insight, and insights enable strong business decisions that promote progress and growth.

For supply chain operators who do not already have a temperature traceability system in place, this updated regulation presents the perfect opportunity to jump into a reliable IoT solution. By offering a way to monitor and track temperature data from production, through transit, all the way to the retail floor, a well-connected IoT system presents your company with the data and insights you need to not only meet the requirements of this regulation, but gain the insights needed to spot inefficiencies and ensure the cold chain is as safe and cost effective as possible.



How Supply Chain IoT Can Help Your Business

Before getting into the details of how IoT works and the technology behind it, you may be interested in learning more about what insights from supply chain IoT can mean for you. In this section we will discuss some of the many applications for the technology.

► Improve supply chain stability

Using IoT to collect and analyze data is key to avoiding supply chain disruptions before they happen. With all the complexity in supply chains, so much can go wrong. Without the ability to trace products as they move, companies are not able to face a problem until it is already too late. You wouldn't know if the shipment is too small until it arrives at the door the day it is needed. Contamination is nearly impossible to trace. Theft is not detected until long after it has occurred.

► Stay on top of quality control

The ability to track where a product has been and when it was there can provide huge value in the realm of quality control. For example, if contamination occurs in a specific plant at a specific time, **a functioning traceability program would be able to pinpoint exactly which assets were affected and where they are in the supply chain.** In this way, the potential damage caused by contamination is better contained, and contaminated products can be removed from the supply chain with a simple phone call to the right plant manager.



► Increase sustainability

Sustainability is enhanced by a reduction of waste, and more control of products flowing through the supply chain can help eliminate waste. Traceability can provide that control. **More control prevents loss, enabling companies to allow for less waste in their predictions and prevent waste from occurring.** Ultimately, this also means less "waste" has to be transported and enables fewer transportation legs, thus resulting in less emissions and fuel used.



▶ Enhanced customer reporting

End consumers are increasingly more interested in where products came from and how they got to them. Whether these questions are ethically based, or signify a health concern, the transparency of a provider through every part of the sourcing and supply chain processes can ease valid customer concerns. In this case, supply chain IoT specifically can play a very important role. **By owning the supply chain fully from end to end and collecting data throughout the process, you can present to customers and their end consumers the insight they need to feel confident in your products.**

▶ Improve efficiency

Because supply chain IoT has the ability to take a look at a supply chain overall, certain insights can be discovered and acted upon to improve overall efficiency. For example, if a supplier is delivering assets late repeatedly, the system would pick up on that and report that inefficiency. Or, if drivers are facing repeated traffic issues in the same place or at the same time of day, insights collected can improve predictions and allow supply chain managers to operate with more advanced notice of delays.

▶ Track Temperature

Maintaining the cold chain is a strong use case for supply chain IoT. **By placing temperature tracking technology on packaging or directly next to the products themselves, quality and operations teams can get a real time view of when temperatures change, how often, and where these changes are most likely to occur.** Even the effect of seasonal or climate changes can be watched to ensure safe transportation of the most perishable goods.

Fundamentals

What is Supply Chain IoT made of?

In reality, traceability in supply chains represents an umbrella of technology, defining several different tools used to create traceability or supply chain IoT. There are two major distinctive categories within the umbrella: **Passive tracking** and **Active IoT**.

Passive Tracking

Passive tracking, or “push and pull” generally involves a non-electronic scanner such as a barcode, QR code, or passive RFID tag that is scanned to collect tracking data. This is incredibly useful for tagging individual items at a relatively low cost so they can be tracked as they enter different milestones in the supply chain.

Generally this process is not considered part of an IoT network because elements are not “connected” actively in themselves, however passive tracking is a critical part of overall traceability. Lori MacVittie puts it well in her Information week article: “The fact is, it isn’t feasible to sensor- or Internet-enable everything. Food is clearly one of those categories that simply wouldn’t be cost effective or realistic to connect directly to the Internet of Things. But that doesn’t mean food -- and other consumables -- can’t participate via other directly connected “things.”⁴ **In other words, for a supply chain manager hoping to keep track of every single item flowing through the supply chain, passive tracking is likely part of that decision and will enable supply chain operators to collect data on individual items in a cost-efficient way.**




























Active IoT

Active IoT involves any device that gathers or conveys information with another device. This process involves sensors, active RFID, Bluetooth, WPS (WIFI Positioning System), GPS, and Micro Geolocation. There are many ways active IoT can be used and it has flowed into every part of our lives. From the watch on your wrist, to the sensors detecting temperature changes in grocery retail fridges, to medical devices administering medications.

The number of active IoT devices entering the network increases exponentially every year. According to IT magazine Helpnet Security, the number of active IoT devices is expected to reach 24 billion by 2030, up from 7.6 billion in 2019⁵. **This constant feed of information passing from one device to the other enables major increases of efficiency and positive structure and has already changed the world as we know it.**

Inside the Tech

A range of technologies can be used in a supply chain IoT ecosystem depending on your cost, accuracy, range and battery requirements.

		Location Accuracy	Range	Tracking Frequency	Energy Consumption	Notes
Passive Tracking	Barcode \$	At scanned location 	Visual Range ~1 m	Scan Tracking 	Passive 	<ul style="list-style-type: none"> • Easy to implement • Must scan to get data • Not ideal for bulk scanning
	RFID (Passive) \$	At scanned location 	~1 m 	Scan Tracking 	Passive 	<ul style="list-style-type: none"> • No line of sight required • Mature, proven • Weak signal, interference
Active IoT	RFID (Active) \$\$	At scanned location 	~100 m 	Scan & Process 	Active - Medium 	<ul style="list-style-type: none"> • No line of sight required • Strong signal • Better for bulk scanning
	Bluetooth / BLE \$\$	~10 m 	~50 m 	Continuous 	Active - Low 	<ul style="list-style-type: none"> • Lowest cost for active device • Weak signal; network interference • Very low energy consumption
	WPS (WiFi Positioning System) \$\$	~30 m 	~100 m 	Scan & Process 	Active - Medium 	<ul style="list-style-type: none"> • Indoor & outdoor locationing • Accurate in urban areas • Less accurate • WiFi connection required
	GPS \$\$\$	~10 m 	Global Unlimited 	Continuous 	Active - High 	<ul style="list-style-type: none"> • Accurate across the globe • Outdoor only • Consumes high energy to ping
	Micro Geolocation \$\$\$\$	~5 m 	Cellular/Unlimited 	Scan & Process 	Active - High 	<ul style="list-style-type: none"> • Maximum accuracy • Uses cellular and WiFi • Indoor and outdoor • Hardware and service add-ons



The IoT Process: How the System Works

There are multiple processes that fall under the “IoT umbrella” and not all are the same. That said, with some exceptions, most processes operate with a similar sequence of events.

The passage of information in Supply Chain IoT starts with trackers attached to traceable objects. These are the passive barcodes and RFID tags, as well as the active Bluetooth, GPS, WPS and Micro Geolocation devices. These devices send information (or in the case of passive tracking, are scanned) and transfer aggregated data through gateways to the cloud. The data then needs to be communicated, and is often reported on a readable dashboard or chart. Most IoT systems make this accessible with an app as well so supply chain operators can manage devices based on reported insights. Lastly, supply chain IoT needs to be interpreted and business insights need to be derived from the data in order to improve the process.

Supply Chain IoT Can be Implemented Several Ways

Due to the many aspects of the supply chain and all the data points that could be collected, IoT can be attached to different elements of the supply chain.

In or on machinery in plants, warehouses, and stores

Whether the goal is to track machinery effectiveness, temperature, maintain counts, assess liquid quantity, or something else, there are many reasons to attach IoT systems to immobile objects in your supply chain. This is key to staying on top of quality control and for enabling quick reaction to issues on the front lines of production.

However, as these assets are moving or being transported through the supply chain, immobile machinery cannot track the actual movement of products from location to location. In other words, IoT connected to machinery is limited and cannot provide certain key insights such as location or temperature tracking.



On Products Themselves or Their Primary Packaging

Keeping track of the products themselves can play a critical role in precise traceability and enables customer reporting on a very granular level. E-commerce especially benefits from this type of traceability because in many cases customers expect to be able to check where their packages are and when they will arrive. The ability to trace a single product and its movement allows for strong reporting on overall efficiency and helps to reduce losses.

That said, since most products are only going one way through the supply chain and most packaging is single use, this traceability system would need to be consumable and must be incredibly cost effective as a result. Most companies choose to use passive tracking, leveraging tools like barcode and RFID scanning for these purposes. Attaching an actual tracking device would be too expensive for one-time use. **Because passive tracking networks like this require a scanning device, lost packages and any activity out of network goes completely undetected and in many cases supply chain managers struggle to overcome large blind spots caused by passive technologies.**

On Vehicles

Tracing trucks, train cars, airplanes and ships as they move is another great way to integrate IoT in your supply chain. Tracking data is key for reacting to hiccups such as storms or traffic and updating stakeholders on real-time transportation progress. In addition, being able to spot patterns as they happen on the road can help make arrival predictions more accurate, while major delays can be prevented before they happen. Every sophisticated supply chain network keeps track of vehicles as it is likely that a single truck, plane, ship, or train contains an enormous amount of product and a huge sum of value.

However, this tracing method has its limitations as well. For one thing, **the visibility of product location immediately goes dark the moment a shipment leaves the truck and goes through the door of the facility.** In the cases where product gets forgotten in a warehouse, temperature dips below or above ideal, or is contaminated and mixed among uncontaminated product, tracking vehicles can do little to help.



Four Winning Strategies for Integrating IoT with Secondary or Tertiary Packaging

Appending supply chain IoT to secondary packaging like bulk containers and pallets will illuminate dark spots in your IoT network. This method offers the broadest range of tracking opportunities. **Reusable pallets, bulk containers and crates carry loads of product and can be reused for hundreds of trips through the supply chain. Adding IoT to these products is the sweet spot between high quality tracking and cost efficiency.** It is more cost-effective to track larger, reusable objects with high-quality smart trackers because they can be used many times. In addition, since secondary packaging and pallets go wherever your product goes, there are no dark spots when the shipment arrives at a warehouse or unloading facility. IoT on secondary packaging can even provide other data insights beyond tracking such as temperature, damage level, even sales data.

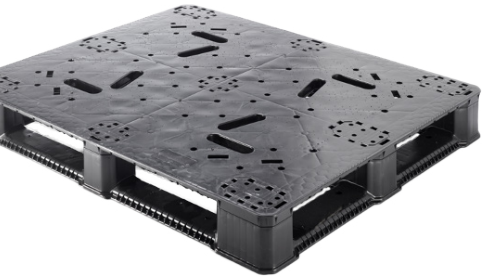
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Illuminate supply chains with connected secondary packaging and pallets

Here are a few real-world examples of supply chain IoT applied to secondary packaging and pallets that promoted efficiency and savings in supply chains.

► Warehouse Teams Predict Shipments with IoT Connected Pallets

A large global retailer's urban drop-offs were experiencing inefficiencies and deliveries were difficult to receive without timely reaction from unloading staff. Without accurate delivery times, unprepared staff scrambled to unload trucks as they blocked traffic. Enter supply chain IoT appended to pallets. Realtime status from active tracking devices showed managers whether shipments were due on time or delayed 10 days so staff could prepare for swift unloading before the shipment arrived. This created a smoother process that blocked traffic for less time and saved staff time.



▶ A Global Cosmetics Brand Tracks Warehouse Supply with Interactive IoT Reporting

Throughout their complex global supply chain, the cosmetics brand was losing track of bulk containers carrying vital ingredients for their products. They determined that it was within their large manufacturing complexes that these mix-ups were happening. They opted to attach active devices to their pooled bulk containers. They experienced an increase in efficiency and benefited from the ability to locate where specific containers were in their warehouses up to only a few meters, presented live to an app on the phones of operations managers.



▶ Grocery Leader Applies Active IoT to Deliverable E-commerce Crates

For smaller secondary packaging like crates, passive supply chain tracking can help reduce losses of valuable assets. A global retailer was losing their reusable plastic home shopping crates at a rate of more than 50% annually as part of their home delivery service. Trackers were outfitted to reusable e-commerce crates with connected “gateways” that pinpoint when crates are checked in or out of delivery vans and stores. This addition is expected to help reduce losses by 90%, providing the grocery leader with major cost savings.



▶ Prominent Supplier Tracks in-store Sales Data with IoT Connected to Displays

A household-name global supplier spent too much time visiting retail stores to ensure they were living up to their end of point-of-purchase promo programs. Attaching active devices to retail displays helped ensure point of purchase displays were in proper areas of the stores, measured foot traffic and correlated that traffic to sales data. This implementation increased compliance from 60 to 82%.

Why Choose Tosca



A well-functioning IoT network within a supply chain depends on three major elements:

1.
Stable, operating
devices

2.
Thorough and well-
planned set up

3.
Intelligent insights
activated by the network

It will involve supply chain, technology, and industry experts all working together to create the ideal solution. It will take communication, testing, collaboration with third parties, and awareness of the industry.

Fortunately, you don't have to be an expert to be interested in the many benefits of IoT insights. Simply choose the right partner to guide you through the process and you are well on your way to a smarter supply chain that saves you money and time.

About Tosca

Tosca is a global leader in reusable packaging and pallet pooling, specializing in creating more efficient and sustainable

supply chains with a diverse range of pooled plastic pallets, bulk containers, retail display solutions, crates, and more. These products are designed to last and offer many benefits to supply chains worldwide.

Tosca offers its own tried and tested supply chain IoT service involving active IoT and passive tracking applied to reusable packaging flowing through your supply chain. Tosca works with you to determine the right packaging and technology to pair in order to generate the most valuable insights. The service also includes a live dashboard to provide the visibility you need to benefit from the insights the





service produces. combinations of different products paired with Asset IQ enable you to measure insights throughout your entire supply chain. Tosca is the only reusable packaging provider that can offer this coverage with supply chain IoT applied to pooled packaging.

The Asset IQ service involves outfitting Tosca's pooled reusable products with active IoT and passive tracking technology and reporting real-time data on an innovative cloud-based visual platform accessible to customers on their own computers and mobile devices. Core capabilities include real-time asset location, the ability to pinpoint asset leaks, and monitoring of asset utilization, cycle times and overall pool efficiency. Tosca will work with customers

to determine the best solution for them by combining the Asset IQ technology and products from Tosca's broad portfolio of reusable pallets, bulk containers, displays, crates, and dollies that best suits the customer's needs. Reach out to our sales team to learn more about what Tosca Asset IQ can do for your supply chain.



Learn more at
toscald.com/supply-chain-iot

Appendix

- [1. How platforming builds a more resilient supply chain - Supply Chain Management Review \(scmr.com\)](#)
- [2. FSMA Final Rule on Requirements for Additional Traceability Records for Certain Foods - FDA.gov](#)
- [3. Temperature Tracking Heats Up: What Tools and Challenges Should You Be Aware Of? - Food Logistics](#)
- [4. How IoT Can Help Solve the Computer Chip Shortage | SupplyChainBrain](#)
- [5. The Internet of \(Passive\) Things - InformationWeek](#)
- [6. Number of active IoT devices expected to reach 24.1 billion in 2030 - Help Net Security](#)