



# How the Internet of Things is Revolutionizing Supply-Chain Management

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# Abstract

IoT technologies are proving revolutionary in their ability to provide inexpensive solutions to some of supply-chain management's most costly and complex problems. More sophisticated and affordable asset tracking, state monitoring, and data collection have granted unprecedented oversight and control over supply chains of all sizes. Recently, the experts have begun to take notice — in 2015 DHL and Cisco estimated that IoT technologies would have a \$1.9-trillion-dollar impact on the logistics and supply-chain industries<sup>1</sup>.

In this paper, we will explain how IoT solutions stand to make such a monumental impact, and describe how Particle is uniquely positioned to implement them:

## **Increased Visibility**

Knowing the location and condition of your assets at all times dramatically improves supply-chain efficiency.

## **Improved Demand Forecasting**

Usage monitoring and other data facilitate more accurate demand forecasting and open up opportunities for novel revenue streams.

## **Improved Customer Service & Compliance**

Reduced delivery times and increased item availability improve customer experience; while sophisticated state monitoring ensures integrity of perishable and other cold chain goods.

## **Reduced Operating Costs**

Reduced fuel costs, asset losses, and customer claims lower the overhead associated with supply-chain management.

## **The Particle Approach to Supply-Chain Solutions**

As the only full-stack IoT device platform, Particle is uniquely positioned to provide the kind of creative IoT solutions that are revolutionizing supply-chain management.





# Introduction

The remote tracking and monitoring of assets is not a new concept. In fact, the invention of wireless telemetry dates all the way back to the 1930s; and its logical application in asset tracking followed quickly thereafter. However, for decades its use was almost entirely limited to military and aeronautic applications. The widespread commercial use of remote asset tracking has, until recently, been prevented by the high costs associated with hardware and infrastructure.

Over the past five to ten years; however, the cost of device connectivity has fallen dramatically. Per-unit costs once measured in the thousands have been reduced to the tens or hundreds, making possible the broad implementation of IoT devices across a variety of fields. And of the many fields capitalizing on these advancements, supply-chain management (SCM) has been one of the most aggressive.

That aggressive adoption can be largely attributed to two key factors — first, and most importantly, are the immediate and readily-apparent benefits that IoT technologies bring to supply-chain management; and second, is the promise of continuous, recurring value.

Unlike most traditional hardware, IoT devices carry recurring costs associated with backend infrastructure. Because of this, IoT technology tends to be most cost effective when its use results in continuous, recurring value for the customer. In the case of supply-chain management, IoT technology provides that continuous value by dramatically increasing visibility, and as a result:

- Improving Demand Forecasting (6)
- Improving Customer Service & Compliance (7)
- Reducing Operating Costs (8)

Over the following pages, we will explore how IoT solutions provide these benefits, and also outline the ways in which Particle is uniquely positioned to implement them.



# Increased Visibility



Visibility is the single most valuable commodity in supply-chain management. Despite that, over 60% of companies lack full supply-chain visibility<sup>2</sup>, and the average inventory accuracy threshold among American retailers is just 63%<sup>3</sup>. Each year, those blind spots result in untold inefficiencies, dissatisfied customers, and billions of dollars in fiscal losses. Fortunately, recent technological advancements have now made it possible to illuminate those blind spots with IoT devices.

Today, a small, 3G-connected microcontroller can identify, locate, and monitor a moving asset in real-time from virtually anywhere on Earth. Meanwhile, more robust and affordable IoT platforms have made it so that data can be easily received, organized, and analyzed over the cloud. Also, functionality such as automated alerts and event reporting are allowing companies to be more agile and responsive in the face of supply-chain disruptions.

In general, the value that IoT solutions can offer to SCM scales with the size and complexity of the supply chain. The larger the supply chain, and the greater number of players involved, the more opportunities exist for IoT solutions to reduce inefficiencies and improve visibility.

Despite this, the falling price of IoT technology has made its use cost effective even on small scales. To help illustrate this, let's look at the ways in which IoT devices can increase visibility along the length of a simple, linear supply chain:



Figure 1: Increasing Visibility Across Supply Chain

By vastly increasing supply chain visibility, IoT devices stand to transform SCM from a reactive process into a proactive one. When fully implemented, IoT-driven data can be widely and immediately shared across every node on the supply-chain, even allowing for the automation of certain processes such as shipping and re-ordering. This heightened visibility and streamlined communication will in turn allow businesses to forecast demand more accurately; improve customer satisfaction and compliance; and reduce operating costs.

# Improved Demand Forecasting



As illustrated in Figure 1, IoT technologies are capable of extending supply-chain visibility well beyond an individual company's immediate purview. By providing visibility across the supply chain, and facilitating communication between individual nodes, IoT devices facilitate more accurate demand forecasting and dramatically reduce the bullwhip effect.

The bullwhip effect — also known as the Forrester effect — describes the all-too-common phenomenon in which small increases in point-of-sale demand result in disproportionate increases in production. Like the cracking of a whip, a small movement at the customer end of the supply chain will become dramatically amplified further upstream. The phenomenon is largely a consequence of low visibility and poor communication between nodes. The results of this effect include increased safety stocks, inefficient production, and excessive inventory.

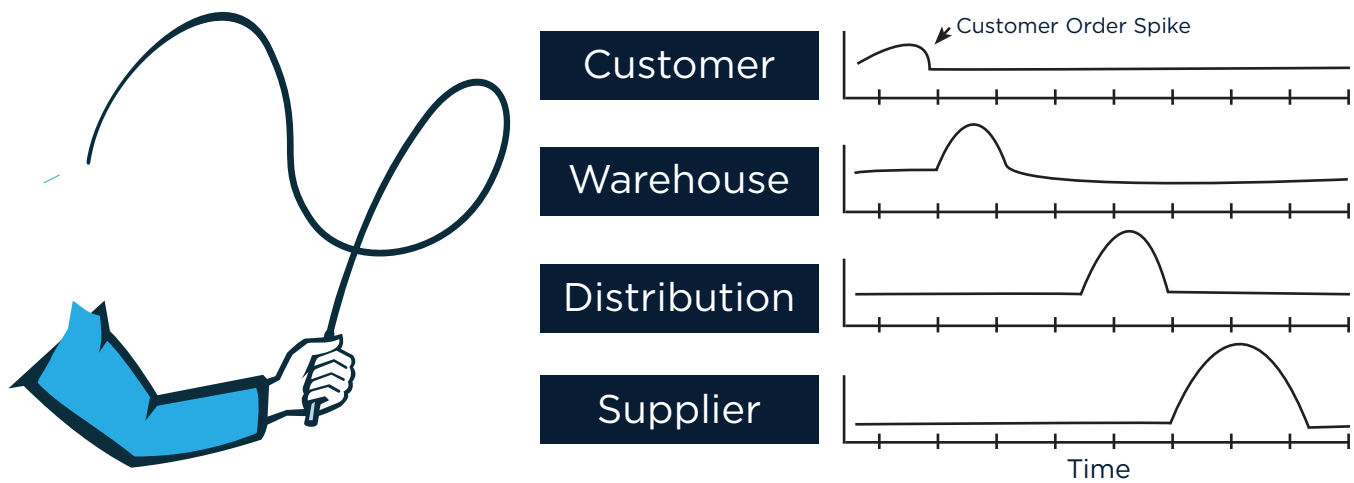


Figure 2: The Bullwhip Effect

To help illustrate how IoT technologies can help reduce the bullwhip effect and other inefficiencies, let's look at a recent use case scenario —

In 2017, Salesforce and Coca-Cola unveiled plans<sup>4</sup> to monitor Coca-Cola's retail sales using IoT technologies. In this use case, an IoT device would take visual inventory of an in-store cooler, then report that data back to Coca-Cola in real time. If the internet-connected cooler was running low on Coke Zero, for example, that information would be shared instantly throughout the supply chain so that Coca-Cola and its distributors could supply more Coke Zero to that particular point of sale. With such robust and timely consumption data, Coca-Cola will be able to better forecast demand, reduce warehousing costs, and prevent out-of-stock situations.

This same functionality also opens up opportunities for novel service models and revenue streams. In the above use case scenario, for example, Coca-Cola can begin offering retailers automatic replenishment options and service-level agreements. Under such a system, internet-connected coolers could automatically reorder products when inventory begins to run low. These kinds of innovative supply-chain models stand to increase efficiencies, boost revenues, and improve overall customer satisfaction.



# Improved Customer Service & Compliance



As seen in the previous use case, IoT technology is proving revolutionary not only in its cost effectiveness, but also in its expanded capabilities. IoT devices can now provide companies with a greater variety of data than was possible in the past. States such as temperature, humidity, and vibration can all be closely monitored using a single, inexpensive IoT device. With this data, companies are better able to prevent asset damage and loss, and provide their customers with faster, more reliable service.

In-transit data such as weather reports, traffic updates, and driver behavior can also be leveraged to reduce shipping times and provide customers with more consistent on-time delivery. That same real-time tracking data can even be shared directly with customers through front-end applications or e-mail notifications to improve overall service experience.

The potential for these types of capabilities are perhaps best illustrated in fresh food delivery models like Amazon Fresh and Instacart. In these models, the traditional risks associated with cold chain management have been elevated. Because perishable goods are going directly to consumers — rather than to retailers — there is one less quality control barrier standing between the supplier and the customer.

In the best-case scenario, inefficiencies and low visibility will result in hungry, dissatisfied customers. In the worst-case scenario, those inefficiencies will result in spoilage, illness, and food safety violations. With an IoT device, however, a package's internal and ambient temperatures can be remotely monitored to ensure quality and freshness. Automated alerts can also be used to notify the customer of delivery, and inform them of how quickly the package must be retrieved and refrigerated before spoilage.



Figure 3: IoT Automating Food Delivery Process

Increased inventory visibility and demand forecasting also improve customer experience by limiting out-of-stock events. In 2015, 88% of holiday shoppers said they purchased a different item, or purchased an item from a different store, because a store was out of the item they were seeking<sup>5</sup>. Not only do these outages result in missed sales opportunities, they also compromise long-term customer preference. Customers who are met with out-of-stock events are less likely to return to that retailer for their next purchase.

IoT technologies also show potential for improving customer service in the retail setting. Remote sensors and monitors can assist retail employees with things like checkout, stocking and inventory; which will in turn free those employees up to focus on direct customer care. IoT technology may also offer unique opportunities for personalized service by monitoring customers' purchases and offering targeted product recommendations in store.



## Reduced Operating Costs

According to the EPA, deadhead mileage accounts for up to 10% of all truck transportation in the United States<sup>5</sup>. All that unproductive mileage comes with immense costs in fuel, equipment depreciation, and reduced fleet efficiency. IoT devices stand to reduce these costs considerably by increasing in-transit visibility and providing more robust data with which to optimize fleet routes.

Forrester illustrated this potential in a brief case study included in their 2016 report<sup>6</sup> on the Internet of Things. In this study, a small, wholesale distributor of marine products employed IoT technologies to increase efficiencies in their supply chain. IoT functionality centered around the real-time GPS tracking and monitoring of the company's 40 delivery trucks and 11 warehouses. Even on that relatively small scale, the distributor was able to save \$14,000 per month in fuel costs, and \$2,000 per week in overtime pay. In a single year, that equates to over a quarter of a million dollars in reduced operating expenses. It is also important to keep in mind that these figures only represent reduced costs. The same increased efficiencies that fueled those savings are likely to generate increased revenues and earnings opportunities as well.

In addition to improved fleet efficiency, in-transit tracking helps companies prevent against asset theft and loss; and advanced state monitoring such as temperature and moisture sensing help protect assets against damage. Minimizing such losses results in compounded savings by reducing the need for claim resolution and reshipping. Finally, improved supply-chain visibility reduces the warehousing costs associated with excess inventory and safety-stock.

Together, all these elements stand to dramatically reduce the overhead costs associated with supply-chain management. In fact, IDC<sup>8</sup> predicted that, by 2018, the application of IoT technologies will result in a full 15% increase in productivity for manufacturers in “innovation delivery and supply chain performance.”







# The Particle Approach to Supply-Chain Solutions

As a full-stack IoT platform, Particle is uniquely positioned to implement creative, comprehensive, and efficient IoT solutions. Our complete platform includes everything you need to develop and integrate an IoT solution into your existing supply chain infrastructure. With that ease of integration comes reduced risk, better performance, and accelerated time-to-value.

## Our Products & Services Include:

### **Cellular-Connectivity Modules (i.e. The Electron):**

The Electron is a custom cellular connectivity module that is preconfigured to connect to the Particle Cloud. The Electron can be sourced directly from Particle, reducing supply chain complexity & risk.

### **Asset Tracking Solution:**

Our asset tracking shield & enclosure can be fitted to the Electron and customized to your unique needs.

### **MVNO/Cellular Data:**

Particle cellular data plans are specifically designed for IoT data use. With low-data-use communication and security protocols, Particle data plans significantly reduce data costs. In fact, our CoAp + DTLS communication protocol is 60x more data efficient than standard HTTPS.

### **Secure-by-Default:**

The Particle platform is encrypted end-to-end and secure by default.

### **SIM Management:**

Particle is designed to scale. The Particle Console allows you to easily & effectively manage SIMs in bulk.

### **Device Management and Firmware Updates Over the Air:**

Firmware updates can be pushed from the Device Console to all of your devices with just a few clicks.

### **Integration with Existing Data, Analytics, & Supply Chain Stack:**

Particle webhooks ensure that your data is never stranded. Our platform allows you to easily move data from between our Cloud and your own internal systems.

### **Comprehensive Development Tools:**

Particle provides a comprehensive set of Integrated Development Environments, API, and SDKs so you can build your own custom firmware and applications.

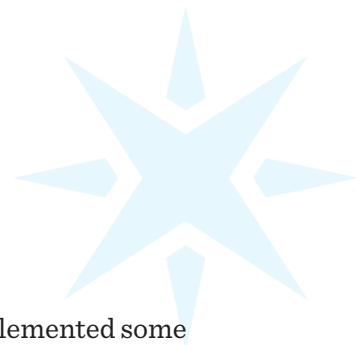
### **A Robust Partner and Service Network:**

If you don't have the expertise or resources required to design your own hardware or software in-house, Particle has a robust network of partners ready to help customize your device.



## The Particle Approach [CONT]

In addition to being complete, Particle also prides itself in being fully customizable and configurable. As a result, Particle currently enjoys the largest IoT Developer community in the world. The flexibility of our platform allows us to work with a variety of clients to create unique, industry-specific solutions to supply-chain challenges. Our sales representatives, engineers, and service partners excel at identifying inefficiencies and developing elegant hardware and software solutions to eliminate them.



## Conclusion

In a recent survey<sup>7</sup>, Forrester found that 19% of companies worldwide have already implemented some form of IoT technology in their operations. An additional 28% reported that they plan to introduce at least one IoT solution in the future.

Of all the use areas surveyed in the report, supply chain management and delivery tracking were the most widely-cited targets for IoT implementation. Of the 3,627 businesses surveyed, 20% had either already incorporated IoT technologies into their supply chains, or were planning on introducing them soon.

These findings reflect a growing, global consensus that the Internet of Things will soon become an integral part of supply chain management. The near limitless opportunities for optimization that IoT technologies afford make their broad application in supply chain management all but inevitable.

Particle proudly stands at the vanguard of this nascent revolution. Our comprehensive, full-stack IoT platform has already proven agile and effective in delivering unique, IoT-based solutions to some of supply chain management's most challenging problems.

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