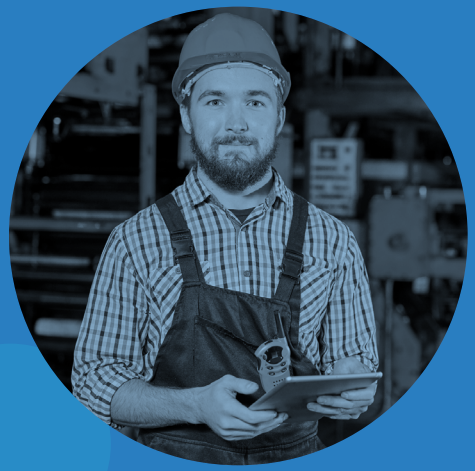
CHAINLINK RESEARCH

IOT: FROM HYPE TO ADOPTION

Five Ways Manufacturers and Distributors are Adopting the Internet of Things

READ TIME:
12 MINUTES

ON THE PLANT FLOOR



The Internet of Things (IoT) is moving out of the hype cycle into early mainstream adoption. Many emerging and growing manufacturers and wholesale distributors are working to determine where IoT fits into their business strategies. A key part of this is prioritizing the numerous potential IoT initiatives. Many of these companies face constraints in budgets, inhouse expertise, bandwidth and technical resources. This makes it even more critical for a growing company to choose wisely on where to start and where to invest in IoT. We look at five major areas that manufacturers and distributors are implementing IoT: 1) on the plant floor, 2) in supply chain and logistics, 3) in service and repair, 4) incorporated into products, 5) creating value-added services.

Manufacturing plants have been instrumented with sensors for many decades. In the past, those sensors were often only used for local control of a machine and process. For example, CNC[1] machines have been in use since the late 1950s. Process control mechanisms have been around even longer (for centuries) but have seen tremendous advancements in the last 50 years. The systems and applications that control factories are often referred to as Operational Technology (OT). These systems tended to be proprietary, isolated and hierarchical in nature. The Purdue Enterprise Reference Architecture (PERA) defines a five-level hierarchy for plant and production control related technology.

> "IoT brings greater connectivity, peer-to-peer/machine-to-machine communications capabilities, more standardization, increased analytical capabilities, and greater connectivity to and integration with enterprise systems."

[1] CNC = computer numerical control systems, which use synchro (aka Selsyn) mechanisms to sense and precisely control the position of cutting heads on machining equipment.

"IoT can be used to reduce variability in manufacturing processes, ensuring proper operations and equipment settings, making automated real-time adjustments and verifying that procedures are faithfully adhered to."

This last phenomenon is often referred to as IT-OT convergence. Thus, IoT can be seen as an evolution building on many IoT-like capabilities already in the factory. IoT is primarily augmenting, rather than replacing the systems in a factory. For example, SCADA technology vendors have been adding IoT capabilities to their systems which allows for increased automation and control within the factory.

A High Bar for Cyber Security on the Plant Floor

IoT systems typically have one or more IoT gateways, which translate proprietary sensors' outputs and industrial system protocols into standardized protocols and data. This makes previously siloed data more broadly accessible. Many of these previously siloed systems were never designed to be connected to the network and hence lack the rigorous security mechanisms required to survive on today's internet. Robust, multi-level security mechanisms have become imperative,[2] especially for factory systems where the consequences of breaches and sabotage can be detrimental.

Production Quality, Analytics and Autonomation

The availability of additional data in real-time provides an increased ability to generate operational alerts. The capability to analyze previously non-integrated data enables ongoing process improvements. IoT can be used to reduce variability in manufacturing processes, ensuring proper operations and equipment settings, making automated real-time adjustments and verifying that procedures are faithfully adhered to. Vision-based inspection systems and precise automated measurement systems are used to improve quality. IoT enables higher levels of factory automation by providing sensor data and connectivity to guide machines and robots.

Remote Visibility

IoT can provide visibility into what is happening across a network of factories, including your own factories, outsourced manufacturers, and suppliers' factories. For example, some apparel vendors use RFID to track, in near-real-time, production status and events at their suppliers' factories.

[2] For more on this topic, see The IoT Security Imperative.

IN SUPPLY CHAIN AND LOGISTICS

IoT in the Warehouse

A modern distribution center (DC) often already has numerous sensor-based technologies. While some don't consider RFID and wireless connected barcode scanners to be IoT, in fact they are connected sensors that provide granular real-time data about the locations of items, cases, pallets, bins, vehicles and workers in the factory—a digital twin of the operations. The increase in ecommerce and small order fulfillment has strained the ability to find enough warehouse labor, leading to increasing automation. Amazon's acquisition of Kiva (robots that bring the items to the order picker) has accelerated investments in order picking automation (or semi-automation). Systems from other solution providers, such as Locus Robotics, provide Amazon's competitors with similar robot-aided picking capabilities. Humans are still needed to pick the items, but these systems have increased productivity by 3X or more. In general, IoT devices also help dramatically reduce picking errors. For example, a smart connected scale can be used to weigh the picked order before the worker seals the box for shipment. Information about which items are being shipped, how much each weigh, and how much the associated packaging should weigh, is used to ensure the right items are in the box.

> "We are starting to see higher adoption of sensors and locating technologies in warehouses and distribution centers, transportation and at suppliers' factories."

“IoT offers the potential for more real-time tracking of products throughout the supply chain.”

Tracking Products Through the Supply Chain

The traditional approach to tracking the status of shipments through the supply chain involves a combination of EDI messages, emails and phone calls, with accompanying delays and inaccuracies in the information. Major parcel carriers use IoT technologies (GPS, connected scanners) to more precisely track the status of packages. IoT offers the potential for more real-time tracking of products throughout the supply chain, but not without challenges. For one thing, the trucking industry is highly fragmented—there are over 37,000 trucking companies in the American Trucking Association alone, and the US Department of Transportation has over half a million for-hire carriers (trucking companies) on file. Many of these are mom and pop shops with no tracking capabilities. This makes end-to-end tracking challenging. Several networks[3] have emerged that leverage drivers’ phones and/or in-vehicle devices to track the location of vehicles.

End-to-end tracking, especially for overseas shipments, can be even more challenging as it involves multiple handoffs. There are several startups[4] that are trying to address this by attaching a GPS device to containers or pallets to track them from source to destination. Different companies use different backhaul technologies to send the location information, either continuously or at waypoints. These include cellular, satellite (expensive), AIS (for the ocean leg), WiFi, and even Bluetooth. These are often combined with GIS[5] systems, such as from esri.

[3] Such as MacroPoint (acquired by Descartes) and FourKites.
[4] Such as Tive and ODYN
[5] GIS = Geographic Information Systems

Condition Monitoring and Perishables Supply Chains

Temperature, humidity, shock and vibration, and other sensors can be used to monitor the condition of goods traveling through the supply chain. These are typically incorporated into service offerings from carriers, 3PLs, or solution providers. For perishable food items, companies like Zest Labs offer not just end-to-end temperature tracking, but the shelf-life models, process modeling, and intelligent distribution algorithms required to squeeze waste out of the system. Typically, DCs use FIFO (First In, First Out) algorithms to ensure stock rotation. More sophisticated operations use FEFO (First Expired, First Out). With accurate shelf-life models, based on end-to-end temperature tracking, the true number of remaining days of freshness is known. Temperature tracking can also be valuable for temperature-sensitive pharmaceuticals, such as biologics. In that case, it becomes critical to know the extent of any temperature excursions, as lives may depend on efficacy of the drugs and degradation cannot be observed from visual inspection alone.

> “Temperature, humidity, shock and vibration, and other sensors can be used to monitor the condition of goods traveling through the supply chain.”

IN SERVICE AND REPAIR

Predictive Maintenance

Predictive maintenance is enabled by IoT sensors embedded into products in the field and equipment in plants, combined with machine learning algorithms that find predictive patterns in the sensor data. Traditionally, equipment is repaired based on elapsed time or hours of use. A margin of safety is built into the repair period guidelines. As a result, many parts are replaced, and repair procedures are performed long before needed, while other machines fail before being serviced. With predictive maintenance, machine learning algorithms look at various sensor data (temperature, vibration, particles in lubricants, etc.) to accurately predict when maintenance is needed, in line with actual wear and tear. This results in fewer scheduled maintenance calls, using less labor and inventory, while *simultaneously* reducing failures. It reduces the number of emergency situations that require very expensive logistics and labor. According to a DOE survey, implementing a functional predictive maintenance program can reduce equipment breakdowns by 70 - 75%. Predictive maintenance and IoT embedded into products provide a foundation for servitization, moving from selling products towards selling outcomes[6] as discussed below in *Product-as-a-Service* and in *Creating Value-Added Services*.

> "Implementing a functional predictive maintenance program can reduce equipment breakdowns by 70 - 75%."

[6] For more on outcome models, albeit with a software slant, see Outcome-based Business Models for Enterprise Software

INCORPORATED INTO PRODUCTS

End Use Visibility

Fundamental business transformations are possible when manufacturers embed sensors, connectivity and intelligence into their products. Manufacturers traditionally have very little visibility into who is using their product and how they are using it. Warranty registration programs only reach a fraction of the actual users and provide little reliable information about how products are actually being consumed.[7] IoT functionality that provides real value to the end user (not just value to the manufacturer) is more likely to be utilized (provided setup and connecting is simple and painless).[8] IoT capabilities can give manufacturers very specific, fine-grained data and insights into how their products are being adopted[9] such as: frequency of use, duration and time of use, relative popularity of different functions and types of use and how their product may be used in novel unexpected ways. Manufacturers are often surprised at how their products are actually being used (or misused) once they gain that visibility. This can lead them to change the design of their products to more closely match actual use.

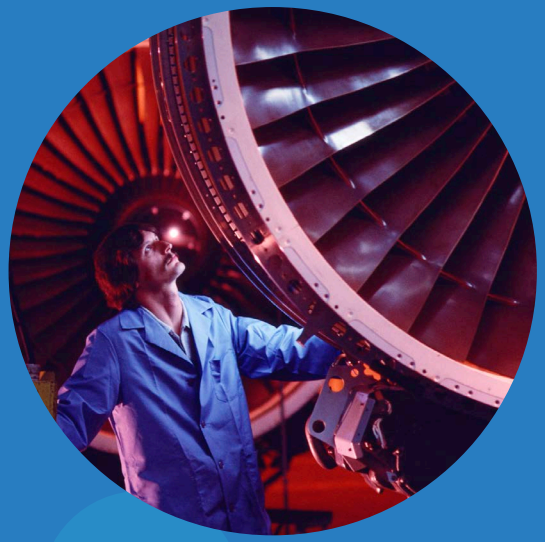
Product-as-a-Service

One of the more profound changes IoT enables is being able to offer product-as-a-service, where customers pay for use or achievement of a specific desired outcome, rather than buying the products. Sensors and connectivity in a product can provide the foundation for usage-based billing. The predictive maintenance capabilities outlined above provide the ability for the manufacturer to offer Service Level Agreements (SLAs) at predictable lower costs. Users win because they can continuously upgrade to the latest technology and are off the hook for

[7] Data from self-reporting on usage via surveys and registration forms is notoriously unreliable.

[8] The user experience in setting up and connecting smart products is critical to adoption and is an area that could use improvement.

[9] Similar to what happens when software solution providers transitioned from on-premise to SaaS models. SaaS providers are able to instrument their software to see exactly what functions are being used, how often, the sequence of use, where users are potentially confused, where there are system performance issues, and more. They have a tremendous amount of visibility unavailable to on-premise solution providers. IoT can provide similar visibility for physical products.



maintaining the equipment. The environmental footprint of products can be significantly improved because products are built to last longer, require fewer repairs and consume less energy and resources (all of which are costs the manufacturer now absorbs).

Mobile/transportation services can be offered on demand, such as the driverless Lyft or Uber services that are coming soon. The customer's interests and the manufacturer's interests become more closely aligned. The cash flow and business model transition to a subscription basis, rather than strictly a product sales model. Examples of product-as-a-service include all three major aircraft engine manufacturers selling power-by-the hour instead of selling engines; Philips customers pay-per-lux with light-as-a-service instead of buying light bulbs; Schaeffler Industrial Services offers bearings-as-a-service for large complex machines like wind turbines or cruise ships with a multi-year, pay-per-rotation contract. Here are more examples and explanation of product-as-a-service's business impact.

"One of the more profound changes IoT enables is being able to offer product-as-a-service where customers pay for use or achievement of a specific desired outcome, rather than buying products."

CREATING VALUE-ADDED SERVICES

IoT built into products enables the possibility to layer on many value-added services. For example, Fleet Advantage leverages data from their fleet of smart trucks[10], combining it with maintenance and route data from their customers to understand true cost per mile (normalized for terrain, load weights, weather and other factors). This allows fleet managers to make smarter decisions, as well as track fuel economy, hours of service, driver behaviors (e.g. excessive acceleration and hard braking) and much more. They can detect when an engine wasn't tuned up properly or a driver is staying too long in the lower gears and other opportunities for lowering fuel consumption (the largest cost for trucking companies). These value-added services reduce maintenance costs and outages, lower fuel consumption, and improve driver safety (reducing accidents and insurance costs). These kinds of high-value services help embed the manufacturer or distributor much more deeply into their customers' businesses. They provide higher margins from more stable ongoing revenue streams, based on subscription business and the value delivered. Moving to value-added services must be done with care, as it represents a major change in the relationship and organizational capabilities required. However, the payoff can be transformative.

[10] For more, see side bar Disrupting the Truck Leasing Business in the article IoT Impact—Part Two

EXAMPLE IOT USE CASES

- Inventory Management – RFID, video analytics and other sensors are being used to keep highly accurate perpetual inventory counts, thereby achieving optimal replenishment and higher service levels, with minimal labor required for cycle counting.
- Robot-Assisted Order Picking – Amazon's Kiva robots bring products to the order pickers, who now stand in one spot as the shelves come to them. Amazon has over 100,000 of those robots across its many DCs. Locus Robotics is providing robot-assisted picking to Amazon's competitors in a different way. The robot follows the worker, instructing them what to pick. After the picker has completed their portion of the order, the robot goes off to other workers to finish fulfilling other items for the order. This cuts way down on travel time for pickers and has increased picking rates about 3X.
- Predictive Maintenance – Sensor data combined with machine learning algorithms are being used to more precisely prescribe what maintenance needs to be done and when on specific equipment. This reduces downtime while simultaneously reducing the cost of maintenance.
- Automated Consumables Replenishment – In business and home settings, machines and dispensors are being equipped with sensors that detect when it is time to reorder supplies. Whether it is a giant bin of plastic pellets feeding a manufacturing operation or laundry soap for a washing machine, the equipment itself pays attention to the levels of consumption and of remaining supply and can suggest or automatically reorder the consumable supplies.
- Product-as-a-Service – Manufacturers and distributors that previously only sold equipment are now selling services where they retain ownership and maintenance responsibility for the equipment. This requires new capabilities but is usually rewarded with a much higher margin business. For example, instead of just selling air compressors, Atlas Copco sells compressed air at specified pressure, dew point, and purity via their AIRPlan service—the customer pays by the cubic meter. In their white paper, Siemens talks about their mature pay-for-use business offerings that are evolving into pay-for-outcomes models.

ENABLERS TO GET THERE

Evolvable ERP, Advanced Analytics

IoT data is radically different from transactional data: with volumes of data that are orders of magnitude higher, diverse machine-level data and real-time streaming characteristics. Traditional ERP systems are not designed to absorb these kinds of data. This requires an integrated set of IoT gateways, IoT applications and enterprise applications. However, an ERP system that has good integration capabilities, the flexibility to incrementally add new capabilities and a solid roadmap for IoT, machine learning, and advanced analytics can help companies along the IoT journey.

Flexible, Unified Invoicing and Revenue Recognition Required

The first two areas explored above—1) on the plant floor, 2) in supply chain and logistics—can transform operational performance. The last three—3) in service and repair, 4) incorporated into products, 5) creating value-added services—can transform an organization's underlying business model. These new business models and new service offerings require flexible billing and invoice recognition. A manufacturer or distributor selling products, maintenance and repair services, product-as-a-service and value-added services, potentially all to the same customer, needs to provide a single unified bill to their clients that clearly lays out all charges and the basis for them. Product-as-a-service and value-added services are recurring subscription services that could be based on just about anything: the number of rotations of a bearing, lumens of light delivered, percent of savings from fuel cost reduction and so forth. The underlying financial system must be able to accommodate all these possibilities for billing while providing compliant revenue recognition. A good example is NetSuite's unified billing and revenue recognition. For more on this, see the section The Need for 'Universal' Invoicing and Revenue Recognition in the article Crossover Businesses: Part Two—Flexibility and Integration Needed to Support Business Model Evolution.

“With the right partners and the right roadmap, IoT leadership is within reach, even for emerging and growing companies.”

Retrofitting: Brownfield Integration Capabilities

Most companies are not in the middle of building brand new ‘greenfield’ plants, warehouses or transportation fleets. Therefore, it is important that IoT solutions are designed to be retrofitted into existing ‘brownfield’ facilities and equipment with minimal pain and complexity. This is not always easy, as older equipment tends to have proprietary interfaces and may not be designed to integrate with other equipment. IoT systems that have rich capabilities to reduce the pain of integrating with existing facilities are helpful in solving this challenge.

Multi-layer Security Designed in From the Start

Security in IoT is critical, especially where lives are at stake, such as in vehicles, dangerous plant equipment, traffic control systems, etc. Furthermore, security is more difficult because of the plethora of attack surfaces and vectors (i.e. potential paths and points of compromise), especially in IoT systems with thousands of heterogeneous, unsophisticated devices attached to them. It is essential that multi-layer security be designed in from the start. For more on the types of measures that should be put in place, see The IoT Security Imperative—Device Security Requirements.

Finding Good Partners and Systems

IoT can be daunting for emerging and growing companies that have limited resources, expertise and budget. In the past, it was extremely difficult to find companies and individuals with IoT expertise and capabilities. Thankfully that is changing, though competition for the best resources is still fierce. Growing companies will do best to choose partners who can take them the distance in strategy, implementation and solutions. Systems with rich, deeply integrated partner networks (such as NetSuite’s Partner Program), can help a company realize their IoT aspirations. With the right partners and the right roadmap, IoT leadership is within reach, even for emerging and growing companies.

About Oracle NetSuite

For more than 20 years, Oracle NetSuite has helped organizations grow, scale and adapt to change. NetSuite provides a suite of cloud-based applications, which includes financials / Enterprise Resource Planning (ERP), HR, professional services automation and omnichannel commerce, used by more than 18,000 customers in 203 countries and dependent territories.

About ChainLink Research

ChainLink is a recognized leader in custom research and advisory services, with a focus on supply chain, Internet of Things, and blockchain. Founded in 2002, our emphasis from the start has been on inter-enterprise interactions and architectures ('the links in the chain'). We have conducted over 75 primary research projects, interviewing and survey-ing over 10,000 executives and professionals. Much of our research focuses on industry-specific use cases, business cases and ROI, and drivers/inhibitors of technology adoption, and business change. As a result, we have developed a deep, multi-industry practice, founded on real-world, validated, supply chain-wide, end-to-end perspectives that have helped our clients understand, plan, and succeed as they move into the future.

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