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Designing for Manufacturing's 'Internet of Things'

The deeper meshing of virtual and physical machines offers the potential to truly transform the manufacturing value chain, from suppliers through customers, and at every touchpoint along the way.

KEEP CHALLENGING™

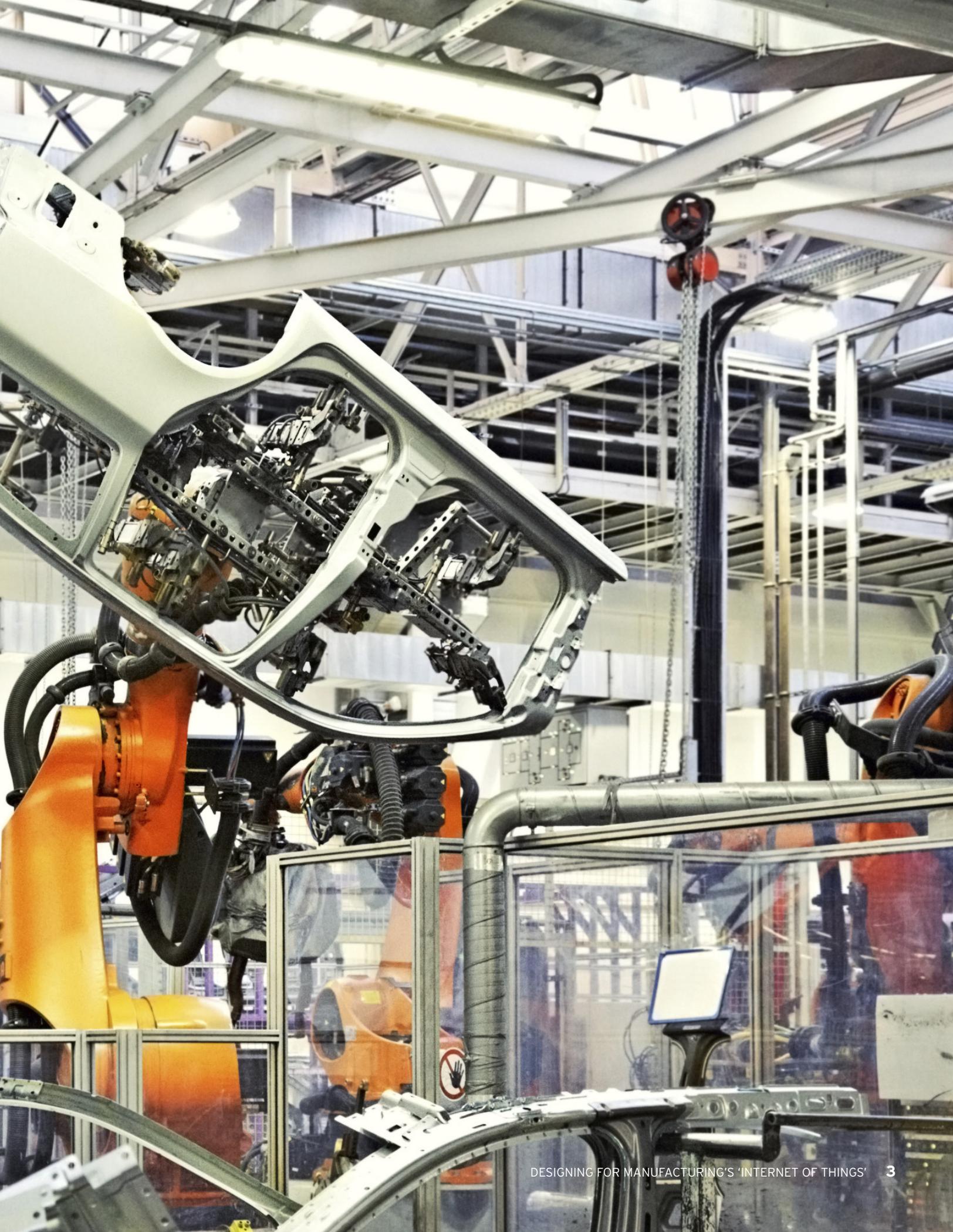
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Executive Summary

Connected devices made possible by the Internet of Things (IoT) are here to stay - and the trend will only grow. As such, IoT presents unprecedented opportunities across industry sectors and processes. Leaders are already investing in IoT solutions – and are reaping benefits. Consider the case of Lido Stone Works, which leveraged IoT to automate streamlined solutions, boosting revenues by 70% and increasing productivity by 30%.¹

Logistics companies and manufacturers in the automotive space and beyond are implementing IoT concepts to create automated and seamless transactions. Designing new business models that support IoT-enabled capabilities requires companies to take a multi-pronged approach, starting with a business model and use case to bring a multitude of technologies together. To automate transactions with IoT, businesses need to deploy sensors, communicate with multiple devices and implant advanced analytics to distill actionable insights. Accomplishing all of this requires a different approach, one that embraces design thinking.

This white paper presents some essentials of the design approach needed to optimize IoT. Organizations need to align their IoT-based solutions to drive value and create a superior experience for customers. Since these applications need to be highly targeted, this paper also outlines industry- and function-specific possibilities for IoT.



Applying Code Halo Thinking

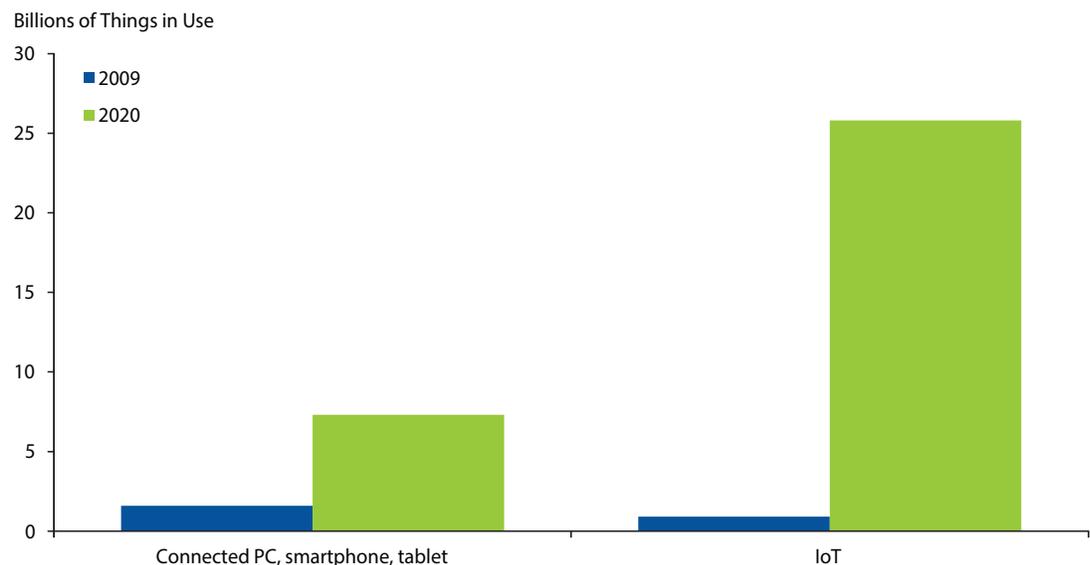
The IoT represents a scenario in which every object or “thing” is embedded with a sensor and is capable of automatically communicating its state with other objects and automated systems within the environment. Each object represents a node in a virtual network, continuously transmitting a large volume of data about itself and its surroundings – we call these digital footprints a “Code Halo™.”² Products built with this capability are often referred to as the new breed of connected products; examples include the smart grid, connected cars and networked and connected factories, all of which represent variations of the same underlying concept.

The IoT can include a person with a heart monitor implant that continuously monitors the patient’s health and alerts care providers in case of an emergency. Other examples include an automobile with built-in sensors that send an alert to the owner’s mobile phone when tire pressure is low, precision farming equipment that can adjust the way each part of the field is farmed, or a home automation system that adjusts cooling and lighting based on the level of activity sensed.³

In a recent report,⁴ according to Gartner, “the installed base of things (excluding PCs, tablets and smartphones) will grow to 26 billion units in 2020, a near 30-fold increase from 0.9 billion units in 2009.” This eclipses even the growth of consumer mobile and computing devices, as illustrated in Figure 1. Importantly, this means that the Code Halos surrounding products will offer organizations unprecedented access and insight into product usage.

The anticipated growth of “things” over the next few years – coupled with the expected cost reduction of adding basic IoT capability to consumer products – means that the majority of devices will be interconnected. We see organizations using online customization tools and quote generation to configure and sell products. One of our clients (a diversified manufacturing organization) allows customers to configure car designs, and arrive at estimated quotes. This information will be transmitted to localized production plants to optimize the supply chain, drive cost-effective procurement and provide real-time visibility of delivery dates.

Figure 1. Growth of Things Will Be Rapid



Source: Gartner (November 2013)

In this landscape, the physical world is highly intertwined with the information world, compliments of the Internet Protocol address scheme, with every object across the value chain sharing and receiving context-specific information for performing a particular task.

Some of the above isn't necessarily new – many organizations have used sensors to capture information for a better part of the last decade. What is different, however, is the high level of device interoperability, the potential for information to traverse multiple platforms, and the emergence of technology that permits companies to manage large volumes of data and uncover deep, hidden patterns.

How IoT Enables Informed Manufacturing

An informed manufacturing organization contains four elements: informed products, processes, people and infrastructure. These essential elements of manufacturing are converging like never before, creating a more automated, intelligent and streamlined manufacturing process, as depicted in Figure 2.

- **Products:** Advanced sensors, controls and software applications work together to obtain and share real-time information as finished goods make their way down the production line. Informed products will enable machines to take autonomous action.
- **People:** By connecting people across all business functions and geographies, and providing them with relevant information in real-time, “informed people” will provide intelligent design, operations and maintenance, as well as higher quality service and safety.
- **Processes:** By emphasizing bidirectional information-sharing across the global manufacturing value chain – from supplier to customer – informed processes lead to a flexible and adaptable supply chain.
- **Infrastructure:** Using smart infrastructure components that interface with mobile devices, products and people, informed infrastructure will better manage complexities and enable more efficient manufacturing of goods.

The Anatomy of an Informed Manufacturing Plant

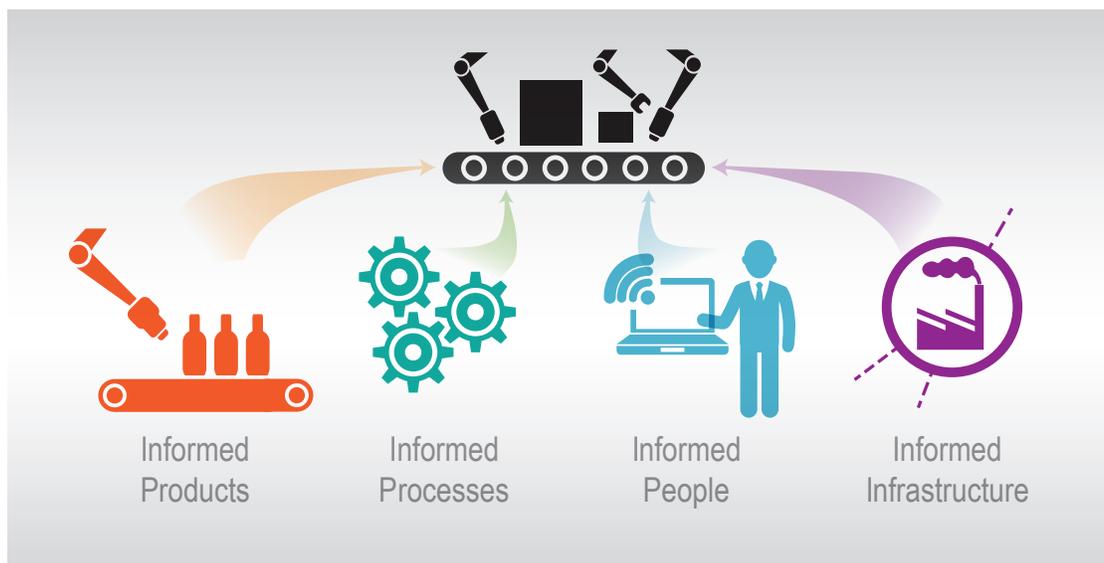


Figure 2

IoT: The Promise and Potential

The pervasiveness of connected devices is not localized to certain industry segments or value chain processes; rather, this concept is finding applicability across multiple segments of manufacturing and logistics, throughout the value chain.

Consider the possibilities across various industries:

- **Transportation and logistics:** Traditionally, logistics and distribution networks are based on a combination of material and information flow between various supply chain participants. The network contains various nodes, and all of the nodes require manual intervention for decisions, actions and issue resolution. Now, consider a scenario where products have sensors and embedded tags. As they move across the supply chain, their Code Halos interact with various partner and in-house systems in warehouses and distribution centers. The flow of material becomes completely autonomous, and various decisions will be made using information captured by readers throughout the supply chain.
- **Energy and utilities:** A network of smart grids, smart meters and smart devices continuously communicate with each other to ensure load balancing and peak leveling of energy consumption, down to the device level. To reduce demand during high peak periods, smart networks communicate with devices when energy demand is high and track how much electricity is used and when. These technologies also give utility companies the ability to reduce consumption by communicating with devices directly in order to prevent system overloads and optimize total cost of energy generation and consumption. Examples include reduction of power consumption by electric vehicles during peak periods and facilitating the vehicle-to-grid flow of charge.
- **Automotive:** Within the automotive space, the “connected car” concept is a game changer.⁵ New car models continuously generate data when in operation; this data can also be used to automatically communicate with other vehicles (vehicle-to-vehicle, or V2V) and with infrastructure (vehicle-to-infrastructure, or V2I) to improve overall driving experience and safety. A relevant example is the

Road Trains

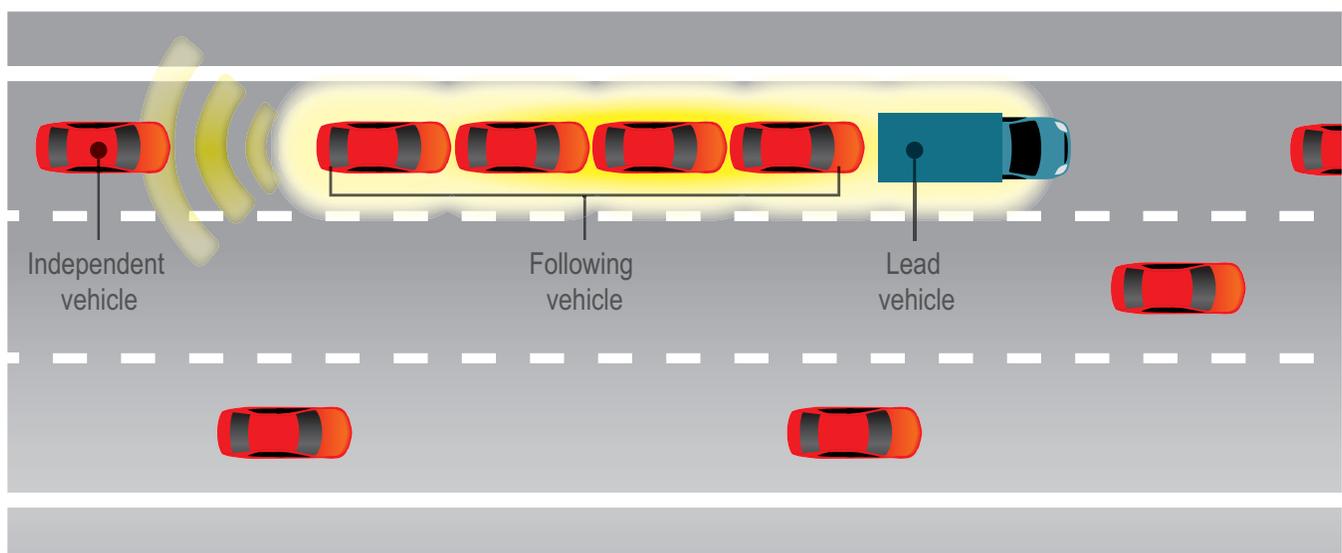


Figure 3

Project SARTRE (or “safe road trains for the environment”), which is pioneering the concept of safe platooning of vehicles. Figure 3 (previous page) illustrates how a set of vehicles is linked via electronic signals, with only the lead driver actively controlling his vehicle; the lead vehicle pulls along the rest like a train. Participating companies advocate that accidents can be significantly reduced if this concept becomes mainstream.⁶

All parts of the manufacturing value chain will greatly benefit from a deep penetration of digital sensors that enable enhanced visibility and better control of production processes, as well as increased automation of tasks. As Figure 4 depicts, applications that encompass IoT principles across the manufacturing value chain – from research and development, through sourcing, production, outbound logistics, marketing and sales – offer huge potential benefits.

A range of possibilities across core functional and process areas also exists. These possibilities are only limited by the ability of organizations to derive meaning from the vast amount of granular time-stamped data generated by embedded sensors in the products and equipment.

- **Connected supply chain** (see Figure 5, next page): By connecting the production line to suppliers, all stakeholders can understand interdependencies, the flow of materials and process cycle times. IoT systems can enable location tracking, remote inventory level monitoring and automatic reporting of material consumption as they move through the supply chain. Access to predictive analytics based on real-time data helps manufacturers identify issues before they happen, lower inventory costs and potentially reduce capital requirements.

An example of the connected supply chain is Dell’s supply chain orchestration, spanning from customers to suppliers. On the customer side, Dell ensures that all its employees are engaged with customers to help them find the best customized choice that fits their need. These orders are then translated to its OptiPlex manufacturing facility, which is able to build more than 20,000 custom-built products.

IoT Applications and Benefits across the Manufacturing Value Chain

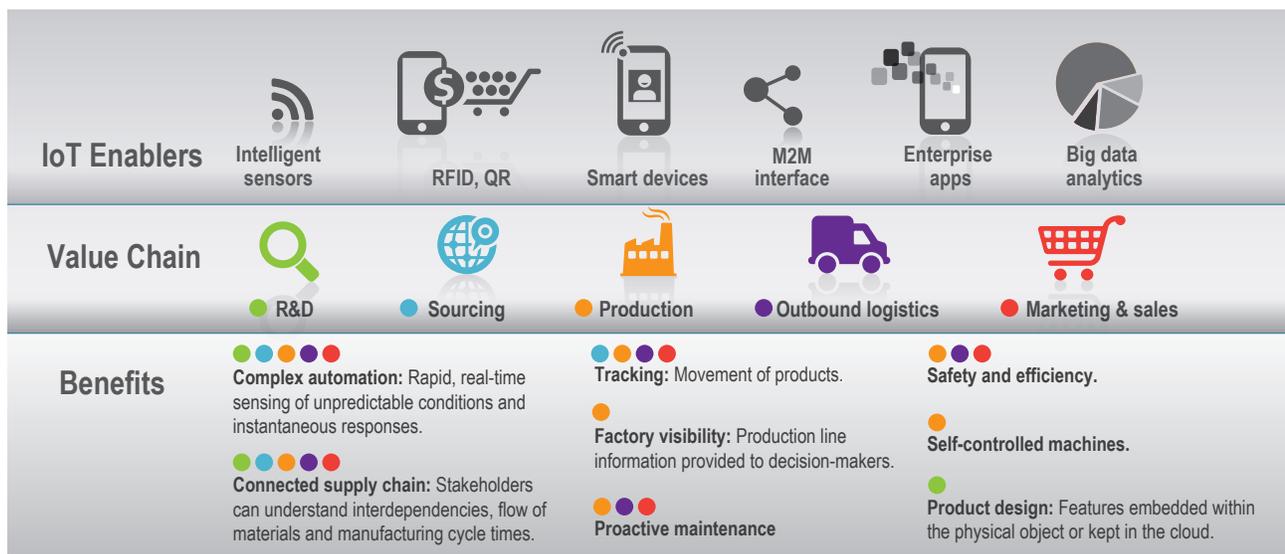


Figure 4

Once customer orders arrive, they are consolidated at the part level via real-time factory scheduling and inventory management. Dell's IoT capability not only enables the company to churn out a revised manufacturing schedule every two hours, but it also enables communications (with time stamps) to suppliers to ensure that required materials are delivered to specific buildings, dock doors and manufacturing lines.⁷

- **Plant floor control automation** (see Figure 6, next page): The IoT data and network provide interconnectivity between the shop floor and top floor, which enables the automation of specific processes and reduces the human intervention required to address issues or deviations. Additionally, sensors can continually measure operating parameters such as temperature, pressure, alignment or thickness at a process level and send this data to a remote controller.

When deviations beyond pre-set control parameters are sensed, the controller can automatically send instructions to actuators to make adjustments to the process. IoT allows such feedback loops to run in near-real-time, eliminating the need for active human intervention and associated time lags. IoT can also advance shop floor visibility by providing continuous status at multiple checkpoints. The benefits of increased visibility extend beyond the enterprise to suppliers and third-party providers. Suppliers will have increased visibility into material consumption on the plant floor and can replenish stock just-in-time, avoiding both stock-out costs and material carrying costs.

In one such scenario, Apotex, a Canadian pharmaceutical manufacturer, upgraded its manufacturing processes to automate manual processes and jettison non-integrated systems. This included ensuring consistent batch production (i.e., automatic identification of materials, addition of ingredients at the right time and communication with the assigned operator) by introducing automated guided vehicles, RFID tracking, sorting and process flow tracking. The end result: the company has real-time visibility into manufacturing operations. Linking this revamp to IoT thinking has resulted in increased productivity and bottom-line

Connected Supply Chain

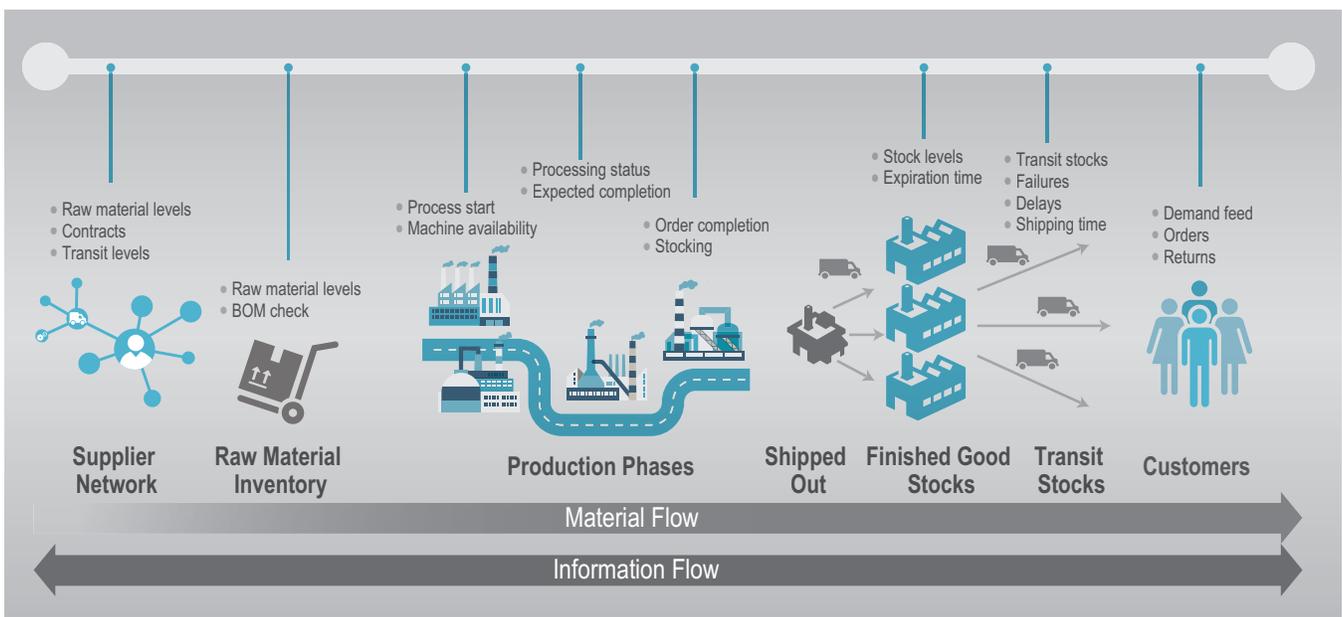


Figure 5

benefits. Further, the facility was honored with the “Facility of the Year” award by the International Society for Pharmaceutical Engineering, which is given to global leaders that demonstrate high levels of quality and creativity in facility design, resulting in significant benefits in production, safety and quality while lowering costs.⁸

- Remote monitoring and management of critical assets** (see Figure 7, next page): While remote asset monitoring has been around for decades, the ability to issue corrective commands is rapidly maturing. Consequently, equipment suppliers have a more direct role in the operations and maintenance of manufacturing plants if they embrace new service offerings and business models. Models can pivot around hours of operation rather than equipment sale, and the buyer gets to use the equipment in an “as-a-service” offering. This will create entirely new and very closely linked business relationships between manufacturers and their suppliers. A leading industry example is GE’s maintenance cost per (flight) hour model for its aviation business.⁹
- Energy management and resource optimization:** Energy is among the highest contributors to cost overhead for manufacturing facilities. Several initiatives are underway to reduce energy consumption, some of which include the use of alternate energy sources. IoT systems and automation of environmental controls, such as HVAC and electricity, can create additional cost savings for manufacturers. Certain IoT-enabled HVAC systems also offer integrated weather data and prediction analysis to help manufacturers understand expenses and plan energy usage. Beyond manufacturing, smart HVAC concepts are being extended into building and home management systems. Several leading players, such as Johnson Controls¹⁰ and Honeywell,¹¹ offer end-to-end automation systems. Google’s high-profile multi-billion-dollar acquisition of NEST attests to the growing interest in smart, energy-saving automation, powered by IoT.¹²

Shop Floor Visibility

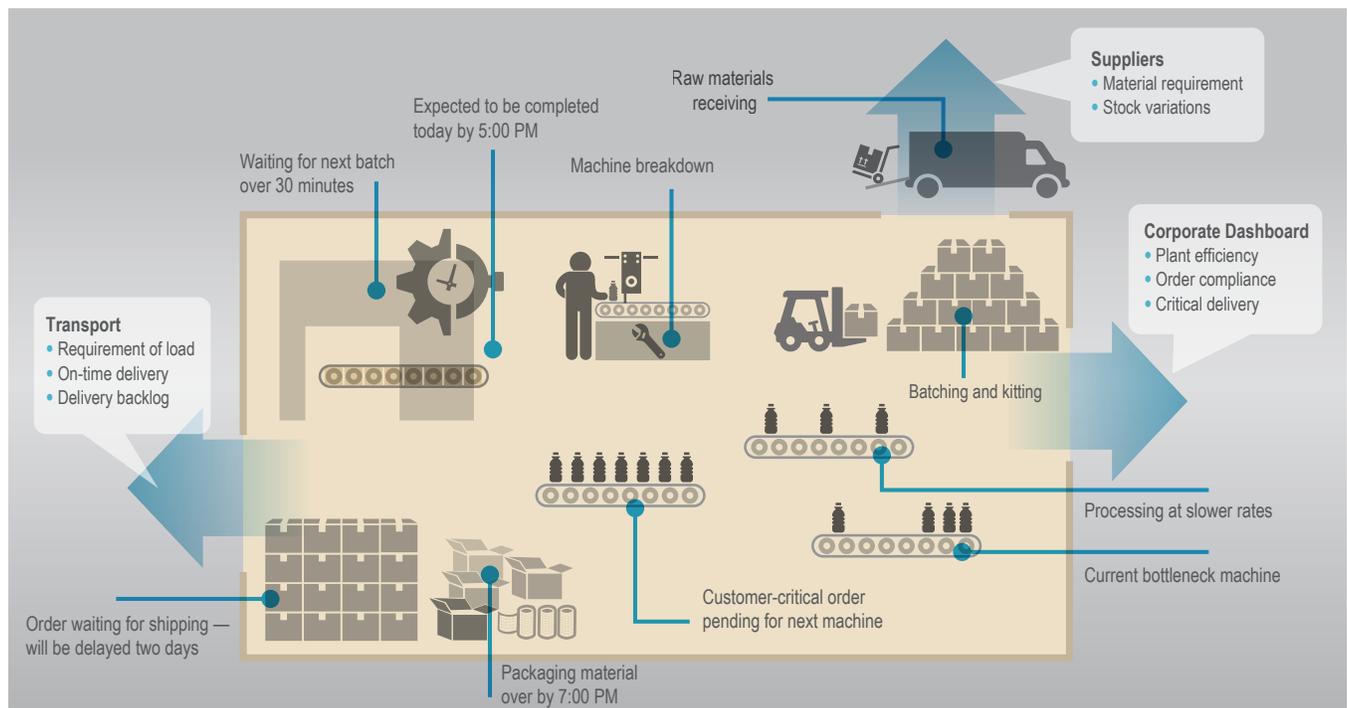


Figure 6

Remote Asset Monitoring

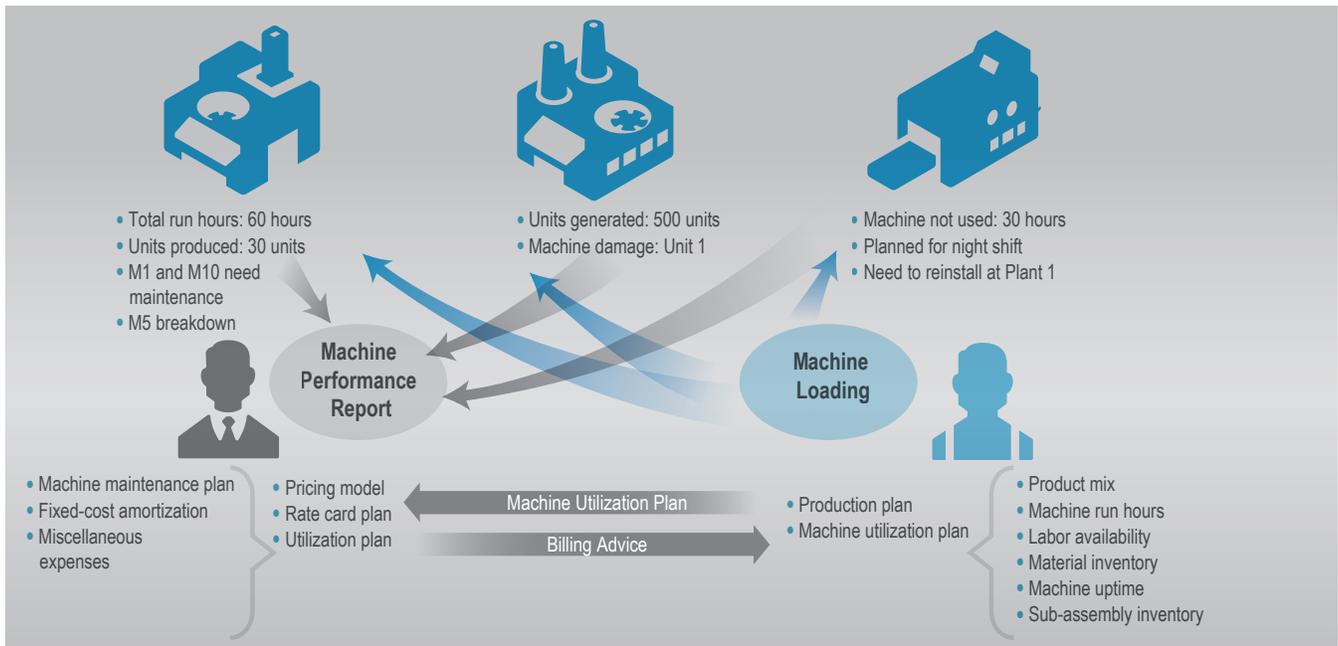


Figure 7

- **Proactive maintenance** (see Figure 8, next page): Manufacturers have widely accepted the concept of preventative and condition-based monitoring, but many are still in the process of implementing these programs. If the manufacturer has equipment that needs to operate within a certain temperature range, the company can use sensors to actively monitor when it goes out of range and prevent malfunctions. Measuring vibrations to detect operations that are out of spec is another example.

Overcoming Design Challenges

Clearly, the IoT presents a rich opportunity for all industry verticals, across processes. Specifically in manufacturing, the IoT can improve and automate decision-making across the value chain. But there are numerous challenges that must be addressed before the full potential of IoT can be realized.

Standardization

A key issue concerns the numerous networks that operate in silos. These networks serve different purposes and, as such, are designed differently. IoT applications are often created for specific purposes within a particular domain and offer limited applications in other areas.

Moving forward, interfaces should be standardized and solutions made interoperable at various levels (e.g., communication and service levels) and across various platforms to promote integration and scalability. Such efforts have already begun; for example, initiatives such as International Standard for Metadata Registries (ISO/IEC 11179) and its implementation (e.g., the Universal Data Element Framework, or UDEF, from OpenGroup) are aimed at supporting semantic interoperability between structured data.

Proactive Maintenance

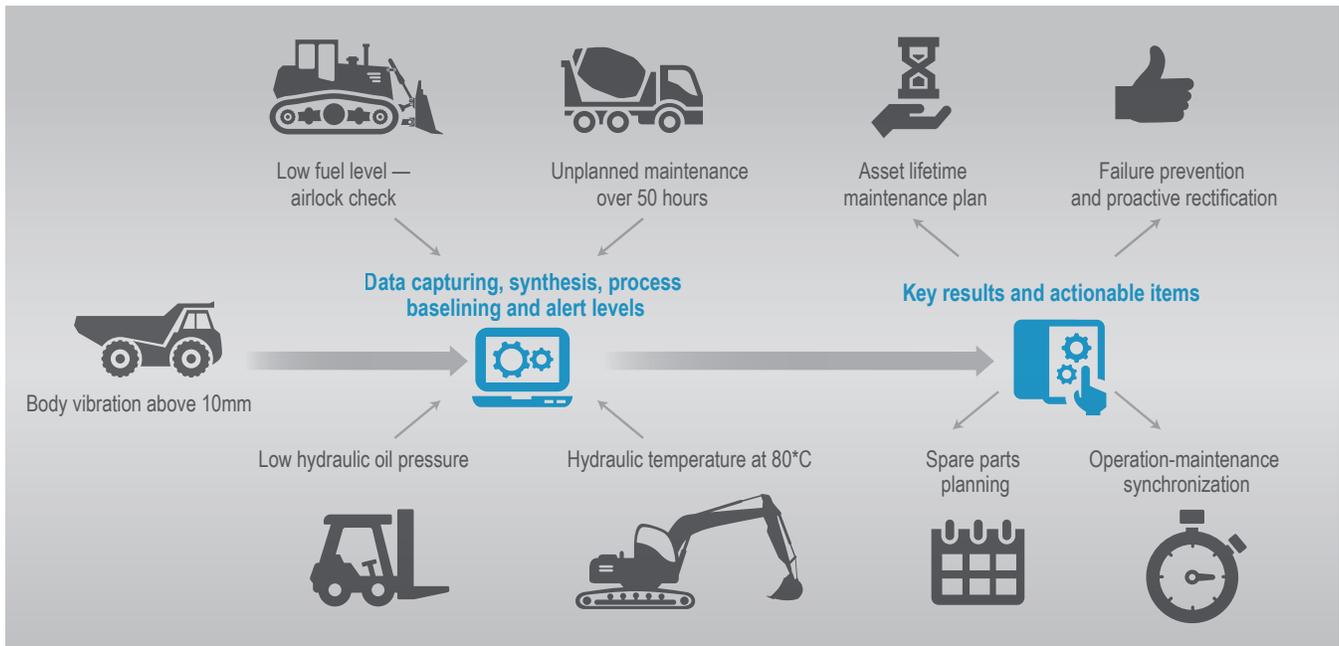


Figure 8

Security and Privacy

With hyperconnectivity, the data associated with IoT goes from big to colossal and from high-velocity to supersonic, and it spans multiple categories (e.g., structured, unstructured and semi-structured). Security and privacy in this environment become even more critical. Devices must be secured on the network, and users need to feel confident both about their personal data and the controls over the flow and exchange of sensitive organizational data.

Infrastructure

The IoT requires complex interconnection between hardware, such as sensors and actuators, and software that works at the assembly level. The impact, particularly on data storage, seems obvious; with so much data being captured and transferred, organizations need much more capacity to store the information. But another dimension is the kinds of data that the IoT captures. The first data type – large file data comprising images and videos – is traditionally accessed sequentially. The second, which comprises billions of small files created by sensor data, must be accessed randomly. Clearly, the data centers of tomorrow must contend with the dual challenge of storage efficiency and effective retrieval of large data sets.

Analytics

Given all this data, organizations will need to master the art and science of converting it into actionable insight. This will likely be the biggest challenge for many manufacturers, given the growth of Internet of data. According to estimates by Stanford University, the world generates around 1,200 exabytes per year.¹³ If we stored this data in 32GB iPads and stacked them one on top of another, the pile (comprising 40.3 billion iPads) would reach the moon! Further, data generation is

expected to grow at 40% per year, which will result in 35 zettabytes by 2020¹⁴ – equivalent to 1,000 Empire State buildings filled with 64GB USB drives.

No wonder that organizations are investing in getting things on the Internet, as they see the potential for generating business-critical insight from this data. Many organizations have started to do this already. For example, the oil giant BP gave its thousands of employees Fitbit devices to track their activity levels. Based on the data that was captured, the company was able to keep its healthcare costs 6% below the UK national average.¹⁵

Moving Forward with IoT

While the challenges can be overwhelming, the following steps can help organizations jumpstart their IoT journeys and build competitive differentiation.

- **Design Step 0:** Analyze sensory architecture.
 - Assess the embedded sensors already in your products.
 - Benchmark the product configuration with competitive offerings.
 - Assess component/subassembly supplier parts range for embedded sensors.
 - Humans-in-loop evaluation for your products and services.
- **Design Step 1:** Create an IoT vision tailored to the organization.
 - Evaluate ROI based on revenue models, efficiency savings and product differentiation.
 - Design a blueprint for your organization's connected ecosystem, including suppliers, dealers, connected workforce and partners.
 - Process: Outline a customer experience design for achieving the IoT vision.
- **Design Step 2:** Initiate engagement and employee communication.
 - Engage and integrate employees, customers, process owners, operators and partners into the IoT program.
 - Communicate with all stakeholders to solicit feedback on touchpoints and potential benefits to make it a win-win for all stakeholders involved.
- **Design Step 3:** Focus on application development and infrastructure.
 - Evaluate potential proliferation of personal connected devices within different stakeholder communities.
 - Create a BYOD implementation plan (if one does not already exist), since this helps to prioritize employee-based applications.
 - Decide on a common approach to development and deployment across multiple devices, including but not limited to data processing and visualization, device support protocols and integration with third-party data (Web services, APIs, etc.).
- **Design Step 4:** Rapid deployment, monitoring and modification planning.
 - Agile and flexible deployment with small, step-by-step implementations. The key is to get started with IoT and achieve incremental benefits
- **Design Step 5:** Developing product features and embedded sensors
 - You are now ready to exploit the potential with additional sensors and start building alliances and partnerships. These can help with further monetization and differentiation.

Footnotes

- ¹ "Lido Crafts Stone with IoT," Microsoft Corp., <http://www.microsoft.com/windowseembedded/en-us/internet-of-things-customer-stories.aspx?id=5>.
- ² For more on Code Halos, read the book [Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business](#), by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley & Sons.
- ³ "Internet of Things," WhatIs.com, <http://whatis.techtarget.com/definition/Internet-of-Things>.
- ⁴ "Forecast: The Internet of Things, Worldwide, 2013," Gartner, Inc., Nov. 18, 2013, <https://www.gartner.com/doc/2625419/forecast-internet-things-worldwide->.
- ⁵ For more on the connected car, read <http://www.cognizant.com/InsightsWhitepapers/Exploring-the-Connected-Car.pdf>.
- ⁶ "The SARTRE Project," SARTRE, <http://www.sartre-project.eu>.
- ⁷ "Dell: Building a World-Class Supply Chain Solution," Intel Corp., http://cache-www.intel.com/cd/00/00/10/17/101709_i2dell.pdf.
- ⁸ Dave Patterson, "Plant Expansion for Apotex Includes Factory Automation and Plant Floor to Top Floor Integration," Grantek, Aug. 17, 2012, <http://www.grantek.com/manufacturing-automation-plant-expansion-apotex/>.
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- ¹² Nest Web site, <https://nest.com/thermostat/saving-energy/>.
- ¹³ Jeffrey Heer, Michael Bostock and Vadim Ogiewetsky "A Tour through the Visualization Zoo," Stanford University, <http://hci.stanford.edu/jheer/files/zoo/>.
- ¹⁴ "Big Data: The Next Frontier for Innovation, Competition, and Productivity," McKinsey Global Institute, May 2011, http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation.
- ¹⁵ Parmy Olson, "The Quantified Other: Nest and Fitbit Chase a Lucrative Side Business," *Forbes*, May 5, 2014, <http://www.forbes.com/sites/parmyolson/2014/04/17/the-quantified-other-nest-and-fitbit-chase-a-lucrative-side-business/>.



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About Cognizant

Cognizant (NASDAQ: CTSH) is a leading provider of information technology, consulting, and business process outsourcing services, dedicated to helping the world's leading companies build stronger businesses. Headquartered in Teaneck, New Jersey (U.S.), Cognizant combines a passion for client satisfaction, technology innovation, deep industry and business process expertise, and a global, collaborative workforce that embodies the future of work. With over 75 development and delivery centers worldwide and approximately 178,600 employees as of March 31, 2014, Cognizant is a member of the NASDAQ-100, the S&P 500, the Forbes Global 2000, and the Fortune 500 and is ranked among the top performing and fastest growing companies in the world. Visit us online at www.cognizant.com or follow us on Twitter: Cognizant.

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