**IoT Scenarios for Manufacturing**

We saw in Module 1 that IoT is transforming manufacturing and industry in general. In this topic, we'll survey some specific examples of how IoT is being used in real-world situations and how companies are using IoT to transform their business.

**Rolls-Royce**

Rolls-Royce has more than 13,000 engines for commercial aircraft in service around the world, and for the past 20 years, it has offered customers comprehensive engine maintenance services that help keep aircraft available and efficient. As the rapidly increasing volume of data coming from many different types of aircraft equipment overtakes the airlines’ ability to analyze and gain insight from it, Rolls-Royce is using the Microsoft Azure platform to fundamentally transform how it uses data to better serve its customers.

To bring its vision of a powerful and scalable data analytics system to life, Rolls-Royce chose to build it on the Microsoft Azure platform. “We realized early on, as customer and engine data volumes increased, that we were looking at a big-data problem,” says Richard Beesley, Senior Enterprise Architect Data Services, Rolls-Royce. “We quickly concluded that a cloud platform like Azure was a ready-made solution for us.”

Beesley explains, “With Microsoft, it isn’t just about the infrastructure, it’s end-to-end and global. There are the skills, the capabilities, the service offering, the development environment, the security. It all just fit together.” Once Rolls-Royce started to collaborate with Microsoft, it began to develop a number of new capabilities using an expansive set of Azure platform services.

Starting with Azure IoT solution accelerators, Rolls-Royce will be able to collect and aggregate data from disparate and geographically distributed sources at an unprecedented scale. “With the increase in the volume and velocity of data that we’re looking at, Microsoft Azure IoT solution accelerators will have a key part to play in our ability to reliably aggregate data across our customers’ fleets,” Beesley says. Initially, the types of data being processed include snapshots of engine performance that the planes send wirelessly during a flight, massive downloads of comprehensive “black box”–type data, technical logs, and flight plans as well as forecast and actual weather data provided by third parties.

[read the full story here](http://customers.microsoft.com/en-us/story/rollsroycestory)

**OSIsoft**

The Industrial Internet of Things (IIoT) - harnessing data produced by connected industrial sensors and devices - is predicted to have a larger impact on global economic output than any of the other big data sources. IIoT data also promises to help solve complex problems that have far-reaching impacts, but deriving the value from that data is going to require the use of sophisticated analytics. For more than 35 years, OSIsoft has been a leader in helping organizations capture operational data from industrial equipment. Today, the company is on the front lines of helping businesses use highly advanced analytics to gain valuable operational intelligence from their sensor-based data.

Long before people were talking about the IIoT, OSIsoft was capturing, processing, and sharing data from industrial sensors and equipment to help its customers optimize their operations. The company’s PI System provides data infrastructure for organizations in several key industrial sectors, including oil and gas, utilities, pharmaceuticals, food and beverage, water, metals and mining, pulp and paper, and chemicals. It collects data from more than 1.5 billion sensor-based data streams at over 19,000 sites in more than 125 countries.

By consolidating and visualizing massive volumes of high-fidelity, time-series data & events from disparate sources, OSIsoft helps businesses improve efficiency, sustainability, quality, and safety. Whether it’s saving an energy company millions of dollars a year through better wind forecasting or helping a mining company better organize its supply chain to boost iron ore production by millions of tons annually, OSIsoft enables organizations to use their data to improve their operations and make better decisions.

This study illustrates that the architecture for an IoT manufacturing solution must go beyond merely collecting data to ensuring that the way the data is collected and stored to how it is analyzed must be architected properly to provide reporting models that are effective at addressing the business problems the solution aims to solve.

One option for experimenting with the right data solution is to model the IoT solution in a simulated environment so various approaches can be tested, modified, and enhanced. By exploring simulated interfaces and dashboards, you can get a sense of how equipment all over the world can be viewed holistically, including both an overall view of performance and detailed insight into the status of individual machines. Even if connecting operations around the globe is a much later step, seeing the results of a simulation firsthand can help you refine your objectives and get a better sense of what’s possible. Cloud solutions like Microsoft's Azure IoT can make this modeling easier and faster.

[read the full story here](http://customers.microsoft.com/en-us/story/bringing-the-industrial-iot-to-life-with-advanced-analytics)

**Jabil**

Established in 1966, Jabil is one of the world’s largest and most innovative providers of manufacturing, design engineering, and supply chain management technologies and services. With global operations spanning 102 locations and 28 countries, Jabil helps leading companies in a diverse range of industries become more competitive.

And in recent years, staying competitive requires more than just offering newer, better products. “One of the biggest industry trends we’re seeing is the desire for flexibility and independence,” says Matt Behringer, Chief Information Officer, Enterprise Operations and Quality Systems at Jabil. “We feel a continuous pull that says we want to have things the way we want them, and we want them quicker.” Behringer says that the modern consumer’s expectation of faster, more personalized services has permeated the industrial world, bringing a “whole new level of complexity to organizations.”

For Jabil, an Internet of Things (IoT) approach based on the Microsoft Azure Cortana Intelligence Suite was the only solution that made sense. Behringer says, “If you think about the IoT mindset, and the ability to connect equipment, sensors, people, and whatever else you can think of, we had to look at our factory from the viewpoint of system capability, and then see what we could do to move forward in a way that enables us to be competitive and differentiated.”

[read the full story here](http://customers.microsoft.com/en-us/story/from-the-factory-floor-to-the-cloud-integrating-predic)

**Other Resources and Case Studies**

* Whitepaper: Competing in the digital age of manufacturing
  + Download - [Register for download](https://info.microsoft.com/Enterprise_EN-US_Mftg_IIoTSolutionsWP_RegistrationPage.html)
  + Online - [View online](https://info.microsoft.com/rs/157-GQE-382/images/Industrial%20IoT_Whitepaper.pdf?aliId=865134805)
* Hershey: https://customers.microsoft.com/en-us/story/hershey-office365
* Rockwell Automation: <https://customers.microsoft.com/en-us/story/fueling-the-oil-and-gas-industry-with-iot-1>

**IoT Scenarios for Smart Cities**

Building on the concepts we reviewed in Module 1, the following are examples where cities are using IoT to improve infrastructure and operations making services more reliable and cities safer and more efficient.

**Safer Cities**

Peter O'Dell of Swan Island Networks in [an article](https://enterprise.microsoft.com/en-us/industries/citynext/iot-holds-vast-promise-for-smart-cities-that-plan-ahead/) for Microsoft relates the following, simple example of how IoT can be deployed to make the transportation of hazardous materials a bit safer. He writes,

Take a simple example of an inexpensive sensor that can replace the current signs and decals that appear on hazardous materials containers, particularly tanker trucks. This sensor transmits its status and identity every 60 seconds, but it can also be activated by readers at electronic toll-collection points. The city can collect and process data from the readers in real time to gain a highly accurate understanding of where hazardous materials are located throughout the city—particularly on transit points like major bridges.

In critical scenarios like a major storm or police action, having this data can help emergency services respond in a way that keeps more people safe.

bathroom sink illustrationThe Economist Magazine created what they call a [Safe Cities Index](http://safecities.economist.com/) which attempts to define how 60 cities across the world define security. One segment of this feature titled, “Unlocking the potential of Iot” which covers everything from data management to applications of IoT in the security space. The segment includes a white paper titled, "A City Planner's Handbook to Public Safety" in which they attempt to define how tradition methods along with digitization can help rapidly growing urban areas maintain high safety standards. The executive summary outlines the following key areas of focus–many of them involving IoT technology:

* Biometric identification systems, which have the potential to reduce human error and processing time at borders, will enhance citizen services and immigration control.
* Facial recognition systems and other predictive technologies will shift law enforcement from reactive to proactive.
* Automated surveillance systems will reduce the dependence on human labor and provide round-the-clock monitoring of critical infrastructure such as power, water and telecommunications services.
* Electronic security measures will protect sensitive public administration services from virtual risks, while data analytical tools can predict disease outbreaks.
* Strong information management, through enhanced security measures and data protection schemes, will help institutions and corporations defend against cyber-attacks.
* On-demand systems that integrate information, analyze the data and communicate with first responders and the public will help governments respond to emergencies and disasters.
* Technology platforms will facilitate efficient collaboration between different branches of the government, enhancing inter-agency collaboration.

Many of these types of systems are being deployed in cities around the world and as the technology advances and IoT services become more readily available, more city planners will be looking to IoT to help them manage their responsibilities. You can read more on each of these items by downloading the whitepaper [here](http://safecities.economist.com/a-city-planners-handbook-to-public-safety).

**Improving Field Service**

**Alert: Pothole Ahead**

automobile illustrationIn this simple example, drivers using their phones as the “IoT device” to send data, can alert the municipality of Selangor in Malaysia of a problem and the city uses the information to address roadway problems.

The popular driving app Waze enables drivers to report problems like an accident or roadway issues. Selangor is using Waze data to learn about potholes and fix them. According to [an article](https://vernonchan.com/report-potholes-waze-get-patched-selangor/) in Malaysian technology magazine Vernonchan, when a pothole is reported, “The Selangor State Local Authority will patch the pothole within five days.” While the reporting mechanism is is not fully automated at this stage (but still very much IoT), one can imagine cars fitted with sensors and AI image recognition technology that can detect things like potholes and automatically report those problems to authorities.

**Follow the Water**

In another example, Microsoft [describes](https://customers.microsoft.com/en-us/story/miami-dade-water-and-sewer-government-azure-sql-database-azure-iot-suite-sql-server-2016-power-bi-en) how the Miami-Dade County Water and Sewer Department (WASD) has the task of managing more than 6000 miles of pipes for that region. The county had a system in place to collect large amounts of data but struggled to analyze it quickly enough as well as holistically so they could predict problems and address immediate issues.

The county went from being able to analyze three years of data on one metric of a single station at a time to being able to analyze 22 years of data from more than 1000 stations in a few seconds. This provides a much more holistic view of the system as a whole which can tell the county much more about how things are operating.

**IoT Scenarios for Smart Buildings**

Smart Buildings are a particular example within the general topic of smart cities but they do deserve a topic all their own. Smart Buildings are not merely about enabling operational efficiency (as important as that is). They also are about comfort and providing a better environment for their inhabitants. Let's look briefly at a couple of examples.

**ICONICS**

No longer must engineers manually inspect and tune buildings to run more efficiently. ICONICS smart building software collects and analyzes Internet of Things (IoT) sensor data from building management systems, giving owners visibility into their property’s health, improved energy efficiency, and lower costs. Based in Foxborough, Massachusetts, ICONICS relies on Microsoft Azure Digital Twins to boost software scalability and rapidly deliver innovative capabilities to customers, such as occupancy and spatial analytics.

ICONICS smart building software has run on Microsoft Azure since 2015. ICONICS software acts as an integration hub to building management systems that control heating, ventilation, lighting, and more. It also collects and centralizes each system’s sensor data. ICONICS’ proprietary technology performs visualization and historization of this data while artificial intelligence rules predict when a machine will fail or use more energy than necessary. It also predicts which issues will have the most impact on energy usage or cost, so building managers can prioritize remediation.

"The Microsoft Energy Smart Buildings program has saved Microsoft 20 percent off its energy bills,” says Russ Agrusa, President and CEO of ICONICS.

[read the full story here](http://customers.microsoft.com/en-us/story/iconics-partner-professional-services-azure-iot)

**thyssenkrupp**

Essen, Germany-based thyssenkrupp Elevator is a worldwide leader in elevator technology, and the company is taking its knowledge of urban mobility to the next level with help from its partner, Willow. At its Innovation Test Tower in Rottweil, Germany, thyssenkrupp Elevator is using Willow Twin—a digitalized virtual model of the physical building—to revolutionize the way buildings are maintained and to enhance the experience of tenants and visitors. Willow Twin is built on Microsoft Azure, using a wide range of Azure services, including the recently released Azure Digital Twins.

As today’s cities grow and change, the concept of urban mobility becomes an increasingly important consideration for the people who plan, design, construct, and run the offices and residences that make up those cities. Urban mobility isn’t just about the way that people move around the city—it’s also about the way that people move within and interact with the buildings where they work and live.

“Real estate owners and managers are always seeking ways to reduce costs and increase tenant satisfaction,” says Professor Michael Cesarz, Chief Executive Officer for MULTI at thyssenkrupp Elevator. “We believe that putting intelligence into the building that improves facilities management and analyzes how occupants and visitors use the building is the best way to fulfill their needs. We’re employing digitalization, AI, and Internet of Things technologies to optimize usage at every level and make the building a pleasant place to work, visit, and live.”

To help develop new solutions, thyssenkrupp partnered with Willow, a member of the Microsoft Partner Network that is creating a new category of innovation for the built environment. thyssenkrupp uses the company’s Willow Twin platform, which provides a “digital twin” of the tower that delivers actionable insights to the building managers.

“A digital twin is a virtual replica of the spaces, devices, and people within a building,” explains Joshua Ridley, Cofounder and Chief Executive Officer at Willow. “The digital twin takes in live data from IoT sensors that are monitoring all of the building’s systems—from lighting and elevators to heating, ventilation, and air conditioning—along with data about the way space is being used and occupied. It makes all that data available to owners, managers, and maintenance staff in real time. They can identify problems, track usage patterns, and gain new insights into the way they operate the building and the way people use it. This opens the door to new and better experiences for tenants and visitors.”

**Sam George Interview**

The Internet of Things, advanced computing, virtual reality and artificial intelligence are all technology trends that are creating change in the workplace and live our daily lives. As Steelcase and Microsoft collaborate to build the Smart + Connected Workplace, Microsoft director of Azure IoT, Sam George, spoke to 360 about how the two companies leverage each other’s strengths to create a secure network ready to adapt to the changing ways in which people are working.

[read the full story here](https://www.steelcase.com/research/articles/topics/technology/microsoft-azure-iot-qa-powering-smart-buildings/)

**Further reading**

* [Smart buildings, built on Azure IoT](https://blogs.microsoft.com/iot/2018/06/05/smart-buildings-are-built-on-azure-iot/)
* [Willow and thyssenkrupp Elevator take building smarts to a new level](https://www.willowinc.com/thyssenkrupp2018/)
* [Rigado delivers IoT edge-as-a-service for smart workplace solution](https://www.rigado.com/press_releases/rigado-partners-microsoft-azure-digital-twins-bringing-iot-edge-as-a-service-to-salesforce-tower/)
* [PCL Construction uses IoT with Azure to revolutionize the construction industry](https://customers.microsoft.com/en-us/story/pcl-construction-professional-services-azure)
* [Steelcase Demonstrates the Smart and Connected Workplace with New IoT-Powered Solutions](https://customers.microsoft.com/en-US/story/steelcase-manufacturing-azureiot-en)

**IoT Scenarios for Energy**

Safer and more efficient energy usage is something on that is on the minds of a lot of people these days and effective IoT solutions have enormous potential to improve the production of energy but also the way existing energy systems distribute and use the energy we currently have access to.

**Rockwell Automation**

Here's an example from a Microsoft [customer story](https://customers.microsoft.com/en-us/story/fueling-the-oil-and-gas-industry-with-iot-1) of how IoT is being used by Rockwell Automation to improve how energy is used in a real-world situation.

**Monitoring Oil Production**

The story asks us to consider the incredible (and precarious) journey the gasoline in your car takes from the moment its mined to when it ends up in your vehicle. The journey begins, at a remote offshore oil well more than 500 feet below the surface, being battered by turbulent waves in transport across the rugged North Pacific, only to find themselves traveling hundreds more miles in a pipeline across searing desert terrain. A stop at the refinery and then they were off again, carried by train and truck until finally arriving at your local filling station. Along the way, they passed through countless pumps, holding tanks, meters, monitors and hoses.

With all those myriad systems and variables like weather, corrosion, local transportation scenarios, and mining and distribution equipment, building systems to ensure timely, safe and efficient production and delivery of vehicle fuel requires continual monitoring, maintenance, and adjustments across the entire supply chain.

Rockwell Automation is using IoT to assist engineers in monitoring remote equipment. Using data collected in sensors in drilling pumps (the failure of single pump can cost between $100,000 and $300,000 *per day* in lost productivity according to the article) to build dashboards that engineers can use to monitor the health of the pumps hundreds of miles away. The system can also alert engineers about problems in real-time allow for immediate and more efficient trouble-shooting and minimal down time. According to one engineer, “The last time we had a well trip offline, within five minutes we had a phone call telling us what broke, what to look at, and how to test it . . .”

**Delivering the Fuel**

Rockwell's solution extends to the gas pump as well. They're implementing IoT sensors to enable safer delivery of liquid natural gas which takes up less volume to store and transport than traditional vehicle fuels and is being used mainly in large trucks used to transport goods.

In order to keep the pumping stations operating efficiently and safely, Rockwell is using IoT sensors to monitor pumps and predictive analytics to anticipate failures and keep stations well supplied with the fuel customers need.

Rockwell also is experimenting with machine learning to better analyze the large amount of data being collected from their sensors. Better data analysis can provide better insights into how fueling stations are functioning and may foster innovative ways to distribute fuel more safely and efficiently.

**Other IoT Energy Solutions**

**XTO Energy**

XTO Energy is a subsidiary of ExxonMobil and has major holdings in the Permian Basin, one of the world’s most important oil-producing regions. To overcome the challenges of monitoring and optimizing a vast number of widely dispersed field assets, XTO Energy has been digitalizing its Permian operations. By using Microsoft Azure IoT technologies to electronically collect data and then using Azure solutions to store and analyze it, XTO Energy gains new insights into well operations and future drilling possibilities.

[read the full story here](http://customers.microsoft.com/en-us/story/exxonmobil-mining-oil-gas-azure)

**Emerson**

Emerson research found that $1 trillion in value is lost annually across manufacturing industries to inefficient operations and monitoring of manufacturing processes. That’s because historically, processing plants have used systems that limit the online monitoring of second-tier equipment, like heat exchangers, pumps, or valves. This equipment typically is repaired on a routine maintenance schedule - during which the entire plant is shut down and taken offline for examination - or as needed, based on manual spot checks. The result: Some manufacturing companies have faced challenges achieving their production or financial goals.

In 2016, the company pushed into the digital future by harnessing the power of the Internet of Things in a Plantweb digital ecosystem. This ecosystem offers manufacturers a scalable IoT solution using wireless technologies, advanced instrumentation, and data analytics to improve plant performance.

[read the full story here](http://customers.microsoft.com/en-us/story/emerson-power-utility-azure-iot-machine-learning-powerbi-us)

**Opportunities for the Consumer**

IoT technologies in the power supply industry are also showing up at the home. Years ago, technicians had to visit each home on a regular basis to “read the meter” so the power company would know how much to charge the customer. With IoT, power consumption can be reported in real-time. This not only benefits the provider but also gives the power company the means by which to provide better, and more frequent reports to customers so they have access to the information that can help them conserve or prepare for the bill they will be getting.

As alternate means of electrical power (wind and solar are two examples) become more widely available, IoT will also enable customers to make choices about how best to utilize the options at their disposal. For example, customers who have installed solar panels on their home and collect energy from the sun can “sell back” excess energy to the power company or their neighbor. Internet-connected devices along with real-time reporting on energy collected, usage trends, and available excess power will enable customers to make smart choices about their usage and distribution.

These are just a few examples of how IoT is transforming energy. We hope these examples have inspired you to think of more ways IoT can be used to innovate on our ever-pressing power needs whether it be extending our existing energy sources to get the most out of them or finding new sources of energy.

**IoT Scenarios for Healthcare**

Microsoft has outlined specific scenarios where IoT is being used in healthcare. You can read about these in the [ebook](https://info.microsoft.com/rs/157-GQE-382/images/Remote%20Patient%20Monitoring%20WW%20Health%20FY18%20Q2%20Vertical%20GEP%20Acquiring%20Content%20v2.0.pdf), *From the person to the cloud and back*. We'll survey a couple of them here and look at how the principles and concepts we discussed above are being used in the real world.

**Roche**

Diagnostic devices play a vital role in helping to improve healthcare delivery. In fact, an estimated 60 percent of the world’s medical decisions are made with support from in vitro diagnostics (IVD) solutions, such as those provided by Roche Diagnostics, an industry leader.

To deliver these services cost-effectively, the company explored the use of Internet of Things (IoT) technologies to address the following requirements:

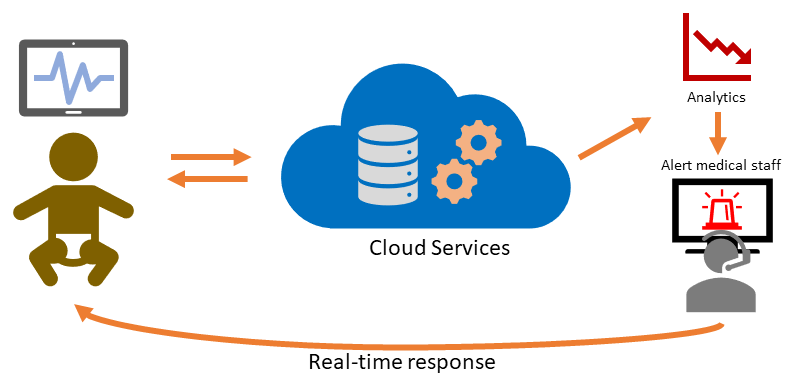
* Remotely monitoring and managing IVD devices as fixed assets.
* Optimizing device availability with predictive maintenance.
* Recommending the best IVD solution for a customer’s needs through data analytics.

[read the full story here](https://customers.microsoft.com/en-us/story/roche-diagnostics)

**CHAMP**

Children's Mercy Hospital in Kansas City Missouri developed a tool which parents use to enter vital statistics for a critical-care baby. The system then analyzes the data. “If there are any measurements outside healthy cardiac parameters, such as oxygen saturation that’s too low or high, the baby’s medical team is automatically alerted.” They call the tool Cardiac High Acuity Monitoring Program or CHAMP.

The solution is relatively simple in its architecture. It uses a Windows 10 laptop or tablet that's connected to a cloud-based database. The data entry is manual–parents enter numbers into an app that sits on the device.



But this illustrates that IoT solutions can start out relatively simply with data being entered manually and aggregated and analyzed by cloud services. One easily can imagine subsequent versions of CHAMP that uses wireless sensors to collect vital statistics securely in real time, aggregate the data into an app that parents can review and send a various intervals throughout the day.

**Predicting Outbreaks**

Medical device manufacturer Becton Dickinson (BD) partnered with Microsoft to build a cloud-based solution that helps aggregate the results of blood tests to help determine trends (such as a flu epidemic) in real-time. As with CHAMP, the architecture of this solution is relatively simple (this is not to downplay the sophistication of the technology itself).

BD builds a device that can offer a quick diagnosis on whether a child has the flu and the data is sent to a cloud-based database. This data is used by the hospital itself but can be used by other hospitals or disease control centers to see if trends are emerging and enable them to act much more quickly to prevent the disease from spreading or develop vaccines.

The company takes its [HIPAA](https://en.wikipedia.org/wiki/Health_Insurance_Portability_and_Accountability_Act) responsibilities serious and has built into its architecture models for keeping private data private. Personal data is removed, leaving aggregate data that can be used to inform population-based health decisions. Even this “de-identified” data has restrictions on use based on data rights agreements put in place between BD and their customers. During a flu outbreak, connected Veritor devices would alert hospitals to consider the potential need to increase emergency room staffing and order additional medicines to support the projected influx of patients.

**Next-generation Healthcare**

These case studies just scratch the surface of what can be done in this vertical to move the healthcare industry forward. This space, perhaps more than any other vertical we'll study has the potential to positively impact billions of lives. The space is nascent and emerging. How will you get involved?

For more information, see: https://www.microsoft.com/en-us/internet-of-things/healthcare

**IoT Scenarios for Retail**

We saw in Module 1 how IoT promises to transform retail into a more personalized, efficient, and secure experience both for the shopper and the retailer. Let's look at a few scenarios where IoT solutions are being developed for the retail experience. Use these scenarios as inspiration for how you might use IoT to enhance your business or industry.

Microsoft has outlined a few specific scenarios where IoT for retail is being used. You can read about them [here](https://www.microsoft.com/en-us/internet-of-things/retail) but we'll review a couple of them to see how to apply this technology to this vertical.

As with all IoT solutions, much of the value of these products is in the data they collect and that can be given to homeowners to build the efficiencies and advantages described in the bullets above. As we've said for the other verticals, privacy and security is of utmost importance in these solutions but if those concerns are accounted for properly, the possibilities are endless.

**Intelligent Signage**

There's a scene in Steven Speilberg's blockbuster movie *Minority Report* where the main character John Anderton (played by Tom Cruise) walks into a Gap store and is greeted by a “smart sign.” The sign does a retinal scan of each person who walks in and uses the unique identity of the retina to personalize the shopping experience. Anderton had his eyes replaced with someone else's so the sign believes he's "Mr. Yokomoto" which makes for an amusing scene since Anderton didn't know whose eyes he had.

The technology depicted in this scene is an advanced version of the kind of personalization that IoT for Retail can offer shoppers. Signs like these can show shoppers sale items that might be of particular interest to him or her based on past shopping patterns (stores may even wish to do “instant” sale prices available only to that particular shopper to entice him or her to buy more items). The company XOGO is [using IoT technology](https://customers.microsoft.com/en-us/story/xogo) to create signage that can turn Windows 10 devices into a digital sign.

While these signs aren't as intelligent as the signs in *Miniority Report*, the idea is that retailers can create interactive, flexible signage using a simple IoT device and a Windows 10 computer and monitor. The interactive piece is what makes this an IoT solution: based on what users click on, spend time on, and search for, the retailer gains insights into what customers care about and can stock their shelves appropriately, better train sales staff, and ensure the customer feels included and welcome.

As we've seen with other verticals, this is a relatively simple solution using a lot of off-the-shelf hardware. Getting into the IoT space does not have to be a months-long project with a huge capital investment. All it takes is an awareness of problems that need to be solved, some creativity, and an intelligent use of cloud services.

**Sam’s Club Now – Reimagining the Future of Retail**

Sam’s Club is working hard on implementing innovations with their Sam’s Club Now location in Dallas. It will be a mobile-first shopping experience powered by the new Sam’s Club Now app. At its core, Sam’s Club Now will be a technology lab that doubles as a live, retail club.

Shoppers will be able to try the following:

* Smart shopping lists: We’ve developed intuitive technology that combines machine learning and purchase data to auto-fill a member’s shopping list. They can easily add or remove things, and as items are scanned the list will automatically update and move the item to their mobile basket.
* Wayfinding and navigation: Gone are the days of wondering where something is in the club. Using voice search capabilities combined with new wayfinding and navigation features, a map will pop up and take members right to what they need. Eventually, we’ll be able to use beacon technology and a member’s smart shopping list to map the best route through the club.
* Augmented reality: We’ll bring items to life in the club by sharing new ways to use them, and we’ll work to integrate stories that highlight cool features, including how items are sourced. We also have plans to use augmented reality to transform members’ digital carts into pirate ships. Or maybe you’d prefer a rocket? More on that soon!
* One-hour Club Pickup: Using the app, members can now place and pickup an order within the hour.

[read the full story here](https://corporate.samsclub.com/blog/2018/10/29/sams-club-now-reimagining-the-future-of-retail)

**IoT Scenarios for Transportation**

**Smart Signals**

In late 2017, the Maryland government announced plans to begin installing “smart” traffic lights in fourteen locations around the state to help clear congestion. According to an [article in the Washington Post](https://www.washingtonpost.com/local/trafficandcommuting/smart-traffic-signals-soon-will-change-themselves-in-maryland/2017/10/25/d4f57058-b9bf-11e7-9e58-e6288544af98_story.html?noredirect=on&utm_term=.67950795aa5c), the new lighting system will implement the following features and benefits:

* The system will use pavement sensors to detect congestion and the lights will adjust their timing to the changing conditions
* The signals will communicate with one another to better manage the flow of traffic in specific regions
* Signals can be modified 24-hours a day and “adjust on the fly” to the needs of the area

Plans for these systems are being discussed for many other locations around the world including a major investment in [Nairobi Kenya](https://enterpriseiotinsights.com/20171027/internet-of-things/maryland-invest-50-million-implement-smart-traffic-system-tag23). Similar systems already have been implemented in various locations in the United States as well. Notably Las Angeles California has implemented its ATSAC (Automated Traffic Surveillance and Control) system which “provides real-time monitoring and adjustment of signal timing for nearly 4600 signalized intersections citywide.” According to [the report](http://trafficinfo.lacity.org/about-atsac.php), the system has reduced travel times by 12% and increased speeds by 16%.

Like the proposed Maryland solution, the ATSAC system uses large amounts of data to analyze traffic patterns and make adjustments accordingly. The data is a central part of this solution which makes it an IoT solution in the strict sense. Specifically the solution:

* Uses sensors to detect the passing of vehicles, speed, and congestions
* This data is received in real time, analyzed, then used either to enable lights to automatically adjust timing or provide manual control to operators
* CCTV (closed-circuit television) cameras also are used to supplement data from the sensors

The results of the program are analyzed (another important piece of an overall IoT solution) and have shown “that travel times, traffic signal delay, vehicular stops, air emissions and fuel use are significantly reduced.” As we've seen in all the verticals, the real value of IoT is [in the data](https://www.raconteur.net/business-innovation/how-big-data-is-now-busting-city-traffic-jams) and what the data can provide in terms of providing better solutions and validating expected outcomes.

**Smart Rail and Air**

We've been focusing mainly on traffic congestion in this lesson mainly because its a problem most people can relate to. But IoT innovations are happening across the transportation space. German railway company Deutsche Bahn is implementing smart sensors along its railway system to help detect early failures and mitigate the conditions that could lead to delays or harm to passengers.

Konux, the company that supplies the sensors for Deutsche Bahn, [describes the system](https://www.konux.com/wp-content/uploads/KONUX-case-study-deutsche-bahn-using-smart-sensor-technology-to-avoid-infrastructure-failure.pdf) as a true IoT implementation. Specifically, the system has the following features:

* **Real-time monitoring**. Sensors placed on tracks sends data to a central system to provide key data points that engineers use to determine track health. This real-time aspect of the solution is central to the IoT models we've been looking at.
* **Intelligent Networking**. Like any true IoT system, this implementation wirelessly transmits data to a central system. This enables the automation that the railway system needs to analyze problems in real time.
* **Embedded Analytics**. Again, true to the promise of IoT, the Konux solution “pre-processes” the data on the sensor and then does advanced analytics in the central system to better predict where problems might occur (or are occurring) and alerts engineers of the issues. Konux uses a proprietary "Andromeda" software platform where "the data are analyzed using machine learning algorithms and visualized on the user-friendly interface."[^2]

This system embodies everything we'd expect in a true IoT solution. It includes sensors that collect and processes data, a central data management and analytics component, and real-time reporting.

[^2]: Source: http://railwayinnovation.com/wp-content/uploads/2016/07/KONUX-1-Pager-Railway.pdf

Similarly, Microsoft has [written a case study](https://customers.microsoft.com/en-US/story/rollsroycestory) about work being done with jet engine manufacturer Rolls Royce to implement IoT sensors in their jet engines to collect and analyze data to help predict failures and potential problems in their engines. Rolls Royce has been collecting data from their engines for decades but needed a better way to analyze the problems in real time and manage the large volume of data coming into their systems.

The case study quotes Senior Vice President at Rolls Royce Nick Farrant who describes some of the benefits of the solution as follows:

Microsoft Cortana Intelligence capabilities are helping us filter the signal from the noise across large data sets so we can focus on finding the real value in the data. Our vision of future digital capability will need to aggregate many sources of data and provide a platform for collaboration with customers.

This example is interesting from an IoT perspective because the implementation Microsoft is providing is helping Rolls Royce with one aspect of their problem space. When we think of how IoT can help customers or provide solutions, we need not think of an end-to-end implementation. Aspects of IoT whether it be the devices component, the data collection component, or the analytics component can be implemented where needed to create a full solution even if parts already exist.

**Where To Next**

These are just some examples of how IoT is being used to transform the transportation industry. Microsoft used to use the slogan “Where do you want to go today?” in some of its marketing. The question when it comes to IoT and transportation is "How can we improve the way we get there?" That is the challenge that you as an emerging IoT architect can help answer.

**Other Resources to Explore**

Read more case studies on IoT and transportation [here](https://www.microsoft.com/en-us/internet-of-things/transportation)

[This article](https://yourstory.com/mystory/e2bda85aa1-how-iot-and-big-data-a) discusses other ways IoT is being use to address traffic challenges.

**IoT Scenarios for Agriculture**

In the early days of IoT, there were industry jokes about the “connected cow” where farmers would use IoT devices to monitor all aspects of livestock management from food consumption to time in an open field to how much waste they produce. While thinking of livestock in this way may not be top-of-mind for most consumers (and this is why some found it humorous), farming is one of the areas most ripe for innovation and modernization.

In fact, farming has been modernizing since it's inception. Modern farms have much more yield per acre, more efficient use of labor, and better land management techniques than their predecessors even 50 years prior. As farmers look for the “next big thing” in agriculture, IoT is at the forefront of innovative opportunities.

**Enter FarmBeats**

[FarmBeats](https://www.microsoft.com/en-us/research/project/farmbeats-iot-agriculture/) is a multi-dimensional program that is working to provide innovative tools across the agriculture ecosystem. For example, in a connected world, we tend to forget that internet access can be spotty to non-existent in rural parts of the world and even in countries that are able to deploy advanced technology, large farms can be cut off from robust connection technology. Microsoft is working for over a decade [on a project](https://www.microsoft.com/en-us/research/project/networking-over-white-spaces-knows/?from=http%3A%2F%2Fresearch.microsoft.com%2Fknows) to use TV white space to deliver data to remote areas (TV signals have a longer range and maintain fidelity over that range than other types of signals and can be more readily available in remote areas). While not an IoT solution per se, this program provides the essential infrastructure that can enable more robust IoT solutions to areas that formerly wouldn't even be able to consider them.

**Sensors and Drones**

In order to make farming more efficient, farmers need data to better understand how their farms are working (data is king in the IoT world). Through the FarmBeats program, Microsoft is working with farmers to deploy ground sensors to farmland, add sensors to farm equipment, and place data-collecting cameras to strategic areas that all collect data sent over TV white space to computers running at nearby buildings on the farm.

These data are collected analyzed in real-time on these computers so farmers can make decisions on critical situations as they happen. Some data can then be sent to cloud services for further analysis to provide more robust and deeper intelligence on how the farm is operating.

A researcher with Microsoft working on the FarmBeats project says it this way,

You don’t have to send all the data to the cloud; it sits on the farm, and is able to ingest a lot of the data, apply the intelligence on top of it to generate actionable insights for the farmer.

As we've seen in the course, this is the promise of IoT

Another cool innovation is the use of drones to create areal maps of farmland that gives farmers a different view on their farms. These drones, using specialized software, create “orthomosaics” (multiple images stitched together to show a single areal view of a farm). These images can then be analyzed to create [heatmaps](https://en.wikipedia.org/wiki/Heat_map) that, "enable farmers to quickly identify crop stress and disease, pest infestation or other issues that may reduce yield."

Similar systems can be used with livestock that will enable farmers to get real-time information on the status of their animals to deal with problems and more efficiently manage transportation, feeding, and other activities.[^1]

**Greenhouse in a Box**

Managing existing farms isn't the only area IoT is enabling innovation in agriculture. [This](https://www.forbes.com/sites/ronaldholden/2018/01/24/data-driven-farming-is-keeping-us-all-well-fed/#aa7a67569e4f) article by Ronald Holden for Forbes magazine highlights a project whereby a large container (cleverly called “Leafy Green Machine” or LGF) can be delivered just about anywhere there is space and enables the operator to grow food–"as much food as two acres of rural farmland"–in the container.

The solution is a true IoT solution in that it uses devices, sensors, and software that “monitors the plants, controls irrigation, orders supplies, and so on.” The article suggests uses cases such as farm-to-table restaurants that want to take more control of their supply chain or schools that want to engage children in agriculture or provide healthier meals.

While the LGF may not be something we immediately think of when we ponder ways to improve agriculture, it does represent an “outside the box” (pun intended) way to think about new ways to grow and deliver food powered by IoT devices and data. As IoT devices and services become more mainstream, solutions like the LGF just scratch the surface of what is possible.

[^1]: See [this](https://news.microsoft.com/transform/farmings-most-important-crop-may-be-the-knowledge-harvested-by-drones-and-the-intelligent-edge/) article for more information.