

LEVERAGE THE INTERNET OF THINGS TO SET UP A SMART FACTORY

Manufacturers today are under tremendous pressure from management and customers to deliver high quality products and services at low costs in a minimum amount of time.

Today's market leaders rightly believe that return on their investment (ROI) is multidimensional, determined by not just costs, but also measures of customer satisfaction and more. Companies are turning to the Internet of Things (IoT) to collect accurate data and convert it into actionable information to help add this extra dimensionality to ROI calculations.

IoT is creating new opportunities for companies to enhance their services, gain business insights from accurate and timely data, improve business processes and differentiate their offerings. This white paper describes the value of IoT for manufacturing and defines an ROI model for building a business case and tracking results related to IoT initiatives.

INDUSTRY 4.0

IoT has the potential to change the face of the manufacturing sector, so much so that it has been called the fourth industrial revolution. If the pace of advancement in technology is anything to go by, intelligent factories will soon become the norm, rather than the exception. The four main factors of a smart factory are IoT, data, automation and precision:

THE INTERNET OF THINGS

IoT is the torchbearer of the smart factory. More than just sensors and other "things," it is the connection of the things to each other in order to facilitate the collection and transfer of data. Multiple types of sensors with the ability to connect to the cloud are installed in the factory to gather data which helps to optimize the factory.

DATA

Data plays an important role in a smart factory, making it possible for managers to gain insights for streamlining manufacturing processes, increasing ROI, and more. IoT can also contribute to an enterprise's big data initiatives, with the ability to collect and transfer massive amounts of structured and unstructured data to save in a centralized location for real-time or future analysis.

AUTOMATION

The IoT system in a factory setting can work autonomously to drive and monitor production with minimal human intervention. And equipment longevity is improved by IoT-enabled predictive maintenance, where IoT sensors can detect faults on the basis of the data collected and independently make decisions to stop faulty equipment before it fails.

PRECISION

IoT sensors and other equipment are designed to sense and measure to an incredible level of precision, making them appropriate for almost any factory application, no matter the size and no matter how exacting.



INDUSTRIAL AUTOMATION

IoT is ideal for increasing the level of automation in today's factories. For manufacturing companies that have already installed sensors, actuators and other low-level devices in their existing industrial automation systems, upgrading and retrofitting IoT-enabled devices is an easy step.

These companies can take advantage of the increase in network speeds and memory size delivered by today's commercial off-the-shelf sensors and other hardware along with well-established cloud platforms. The technology today is robust enough to not hamper the design of the systems as was the case in the past. This will give plant managers new levels of control and insights regarding the production floor.

The key to the success of industrial automation is making use of the data that is gathered.

It's not enough to just collect data. The key to the success of industrial automation is making use of the data that is gathered. The IoT-enabled industrial automation networks collect data and then transfer it to the cloud or to an internal datacenter. There, Hadoop and other technologies are implemented to apply data science techniques and predictive models to analyze the data into useful information.

Another reason for manufacturers to adopt IoT in their factories is to delay or prevent obsolescence.

Many industrial automation systems in factories today will outlive vendor support. By upgrading to IoT systems, plant operators can extend both the functionality and the lifespan of these systems. And as the cost of internet bandwidth and storage has been steadily decreasing, companies can now store terabytes of data very inexpensively compared to even a few years ago.

IoT takes industrial automation even further by interfacing with robust machine-to-machine (M2M) systems. This covers a broad range of technologies used to enable networked devices to exchange data with each other and perform actions without human assistance. M2M technology has applications in almost every area of manufacturing including ensuring plant and personnel safety.

For example, the company's safety engineers can establish safety limits for each piece of equipment. If IoT sensors detect a rise in equipment temperature that brings it to that safety limit, the system will record this fact and it will trigger an immediate shutdown of the affected equipment. Or if the company does not want to implement an automated shutdown system, it can set up the sensors to transmit data to key personnel with remote monitoring ability on their desktops, tablets or other devices. These employees can then send instructions to the machine to shut down, reduce its production rate or carry out any other function in order to take care of the safety issue.

THE IOT VALUE PROPOSITION

IoT also delivers value in areas other than on the factory floor, including remote monitoring, remote service, usage analysis, ERP/CRM integration and much more.

Smart, connected products enable remote monitoring and servicing that drive both a reduction in the costs of service and an improvement in the level of service. Analysis of connected product data can improve business decisions, product design and manufacturing processes.

Core business processes like billing, field service, product registration, compliance, consumable management, recalls and warranty management can all be improved with connected product data. On the other side of the IoT market, the selling and marketing of connected products can deliver a competitive advantage and drive revenue growth.

Following are examples of demonstrating the value that can be derived from enabling IoT in your company

BUSINESS BENEFITS

PRODUCT TRACKING

IoT-connected sensors can help manufacturers easily track products such as raw materials, finished goods, parts and more. Real-time updates provided by the system can allow companies to optimize logistics to streamline and accelerate their processes and cut unwanted costs. Tracking products in real time allows companies to ensure the quality of their finished goods, maintain inventory levels and even prevent theft.

For example, a manufacturing company required an advanced system for tracking their raw materials while they were being transported. Using RFID tags, the company was able to track the exact location of the materials, allowing them to prepare for production while they were enroute and be ready for production immediately after they arrived. Real-time product tracking not only helps the company improve its efficiency, but also helps them save on time and costs.

PREDICTIVE MAINTENANCE

IoT can help you accurately predict the maintenance cycle of your devices, machines and their components by analyzing historical data. Analysis of connected product data can also uncover patterns that are early indicators of failures, allowing you to initialize service. Rather than performing preventive maintenance on a calendar basis when it may not be needed, companies can instead track exactly how much a device has been used to determine whether it's time for service. This eliminates unnecessary preventive maintenance calls and premature repairs or component replacement. Service reps can also perform preventive maintenance during scheduled calls, reducing unplanned and planned downtime and customer interruption. This predictive maintenance knowledge can then feed increased revenues by providing increased uptime with premium SLA pricing.

For example, IoT-connected vibration and noise sensors on machines and other high-end assets collect data regarding the working of the machines and their components. The collected data is analyzed in real-time to determine when machine failure is likely to happen or predict the breakdown of a machine component or part. This helps the factory to carry out maintenance in advance to avoid expensive downtime.

IMPROVED PRODUCT DESIGN

The understanding gained from real end-user behavior and usage patterns can be combined with IoT-collected data to yield information valuable for product designers. The company can combine this data with real-world customer feedback to define next-generation products that will expand market share.

For example, a manufacturer of smart watches installed sensors to collect information about consumer usage. They discovered that many users were rough on the watches, resulting in damage. This insight prompted the company to change the material used to design their watches to make them capable of enduring rougher usage.

IDENTIFICATION OF QUALITY ISSUES

By looking at trends across multiple systems, you can reduce costs by identifying quality issues. Whether from design flaws in parts supplied by third parties or within your own manufacturing processes, looking at the trends helps you to understand what is causing downtime for your customers. Ultimately this can allow you to prevent downtime, reduce repair costs, or streamline the recall process. If problems are of a more serious nature and are still part of the current manufacturing process, IoT-collected usage data may trigger the need to change your processes.

For example, a manufacturing unit unwittingly produced faulty goods that were undetected in the testing stages. However when customers started to use them, the attached noise sensors immediately sent notifications to the manufacturer about out-of-spec noise levels. This data prompted the company to test the product again, and they found the problem. The company immediately recalled all of its batches, the fault was rectified in the manufacturing unit and replacement products were delivered to their customers.

KEEPING ENERGY CONSUMPTION IN CHECK

Energy consumption can be a major expense in a factory, so monitoring is important to help minimize waste and thus reduce costs. IoT-connected components monitor fuel levels and more to find out how much power or fuel is being used by certain equipment, and the collected data can be analyzed to check if it is more than the required amount.

For example, a company decided to use a smart power monitoring system to detect how much power is used by every machine in the factory. When more power than necessary is detected going to a piece of equipment, the system alerts technicians, who can ensure the machine is operating to specifications or that the wiring is correct.

DATA INTEGRATION AND BUSINESS PROCESS EFFICIENCY

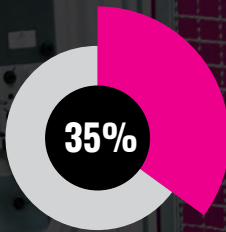
The value of the real-time, accurate data collected by the sensors and systems in an IoT-enabled smart factory can add value to processes almost everywhere in a business. This data can be pulled into data warehouses to be used in systems such as customer relationship management (CRM) and enterprise resource planning (ERP) systems for financial or other analysis. Real-world data on usage patterns or equipment issues can be integrated into quality assurance (QA) or product lifecycle management (PLM) systems, helping improve customer satisfaction and streamline beta programs.

The table on page 10 shows business processes that can be impacted by IoT data and the benefit that can be derived.

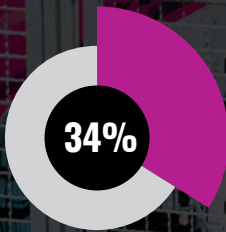
ESSENTIAL COMPONENTS FOR IOT IN MANUFACTURING

While machine-to-machine communication has been around for a while now and a number of manufacturers have leveraged it, IoT remains a new concept due to its components. With advancement in technology, this industry is growing quickly and offering essential components at relatively low costs, making it easy for all types of manufacturers to adopt it.

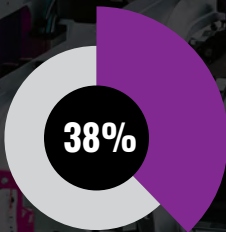
BUSINESS PROCESS	MEASURE	BENEFITS
Customer service	Length and frequency of support calls	Effective troubleshooting and CRM efficiency increased
Field service	Time to resolution	Proactive creation of field service request with accurate data and health status
Warranty management	Number of warranty services, warranty costs	Reduction in warranty service costs and data on warranty compliance
Recall management	Support cases of recalled products	More efficient recalls with accurate data on which product needs to be recalled
Consumable management	Consumable revenue	Increase in sale of consumables
Compliance	Cost of compliance	Reduced costs through more efficient auditing of interactions with machines and humans
Configuration management	Cost of configuration management	Accurate data about installed equipment and configuration



35% of manufacturers in the US have started utilizing data collected by smart sensors to streamline the manufacturing process



34% of manufacturers currently believe that it is critical to adopt the IoT to optimize operations



About 38% of them have already installed sensors in their goods to allow users to gather sensor-generated data

Source: www.themanufacturinginstitute.org

SENSORS

Sensors are the driving force behind the IoT ecosystem in manufacturing. They collect and consolidate data in real time and have the ability to integrate with direct database systems, legacy ERP systems or data warehouses.

DATA INTEGRATION AND BUSINESS PROCESS EFFICIENCY

Internet connectivity has become more reliable and affordable, allowing manufacturers to deploy it in their units. Companies interested in implementing IoT in their factories have a whole range of network standards to choose from. Existing standards such as Bluetooth, Wi-Fi, BLE, RFID, ZigBee, Z-wave and IPv6 are now widely used in IoT-enabled factories. Other emerging standards promoted by some device manufacturers include 6LoWPAN, Weightless and 802.11ah. Choosing the right networking standard depends upon several factors such as device compatibility, your existing infrastructure and your IT team's expertise with the standards.

IOT PLATFORM

The most important part of a smart factory is the IoT platform. Before implementing an IoT integration plan, it is very important to ensure that you have a compatible open architecture in place and that any M2M applications you consider meet your digital business requirements. Take a strategic approach to your IoT initiative to avoid such critical issues as a security breach or interruption in connectivity. Choosing an appropriate IoT platform is an integral step in an IoT strategy, as it will facilitate monitoring and control different data points from a variety of sensors. An IoT platform connects access points and data networks to end-user applications, allowing you to automate processes and analyze data. In other words, IoT platforms act as middleware solutions that connect the data collected at the edge to the user-facing software-as-a-service (SaaS) or mobile app. An IoT solution will include many functions, such as:

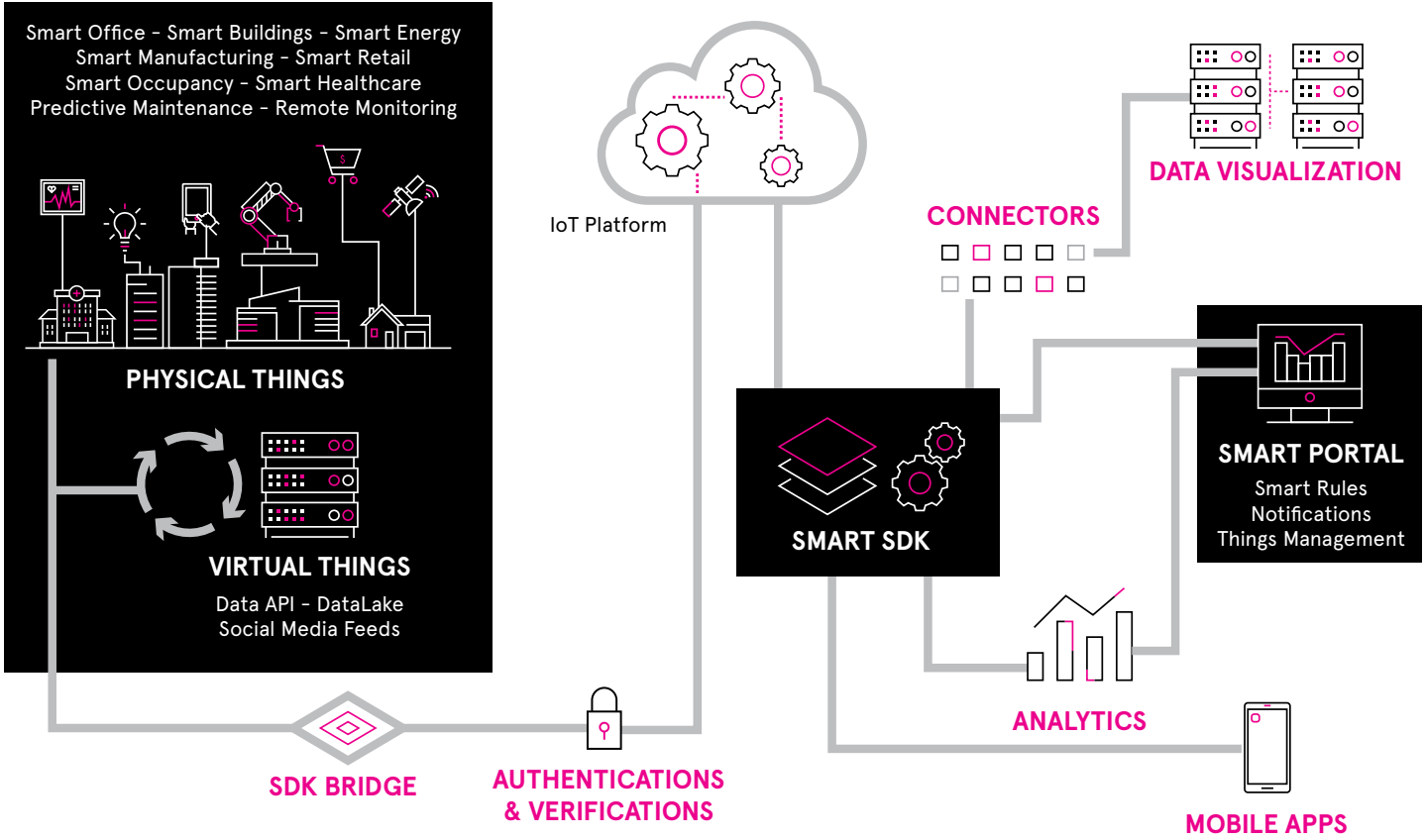
- Sensors and controllers
- A gateway device to collect data and send them back to the server
- A communication network to transmit data
- Data analytics and data visualization software
- A user facing application

THE IOTCONNECT PLATFORM

IoTConnect is a multi-purpose middleware platform developed on open source technologies. As shown in the figure below, this horizontal IoT platform-as-a-service (PaaS) system allows for device communication and management, data storage, app creation and enablement, robust security protocols and implementation of data science methodologies. IoTConnect gives factories the following capabilities:

- Manage multiple connected devices
- Set up cross-device connectivity
- Data visualization reports
- Perform remote device provisioning and configuration
- Perform real-time device monitoring - Distribute over-the-air firmware updates
- Create cloud services for smart products
- Collect and analyze sensor data
- Analyze user behavior and deliver targeted notifications

The main benefits that factories gain from IoTConnect include integration, deployment, security, automation, interoperability, and access.



FLAWLESS INTEGRATION	FASTER DEVELOPMENT	OPTIMUM SECURITY	AUTOMATION	INTEROPERABILITY	CENTRALIZED ACCESS
Enterprise grade integration mechanisms ensure easy adaptation of existing workflows, business processes and information systems.	Create new processes with ease and add business applications through common interfaces for faster development.	Secure data received from all sources of your IoT ecosystem with state-of-the-art data security systems	Operate and maintain device and data tasks by automating business processes and save management costs.	Accelerate time to market, reduce cost deployment and maintenance costs of IoT solutions by utilizing interoperable technologies.	Single point for adapting protocols and data models for gathering the information and managing the communications.



DATA ANALYTICS AND VISUALIZATION

Data analytics is the science of analyzing large amounts of data to uncover patterns and other insights that may be overlooked by humans. The concept of analyzing big data is not new, but the availability of cloud-based storage and analytics tools such as Microsoft Azure and Amazon Web Services among others means that even medium-sized manufacturers can now take advantage of data analytics. The data that has been gathered needs to be converted into easily understood graphs and reports. With interactive data visualizations you can conceptualize future business strategies by drilling down into charts and graphs. Data visualization tools are used by companies to identify new patterns by explaining concepts clearly and deeply. Some of these tools are Tableau, D3.js, Power BI and R.

Tableau is an effective tool to quickly create interactive data visualizations and to explore and find patterns with various combinations. Its simple interface can be used by anyone as this tool is designed to be used by developers as well as non-developers.

D3.js is a JavaScript library that is used for data visualization. It is used to convert unstructured data collected from various sources, such as government databases, social networking, eCommerce portals, etc., into a more usable or productive form.

Power BI allows developers to create accurate visualizations and display data in different ways with minimum effort. The Power BI Desktop includes a variety of standard visualizations, including a range of reports that companies usually need.

R is a popular statistical language that is used with Power BI as well as Tableau to perform statistical and predictive analytics. This includes statistical tests, time-series analysis, linear and nonlinear modeling, classification, clustering and more.

BUSINESS CASE OF IOT IN MANUFACTURING

Every manufacturing company operates production lines that consist of many critical processes, many of which can benefit from IoT. For example, manufacturing controls require continuous measurement of environment variables such as temperature and pressure. Compliance regulations make it necessary to provide safe working conditions for its employees such as controlled noise levels, water quality and more.

TYPES OF SENSORS

Sensors throughout the production unit monitor critical processes, environmental variables and parameters that affect product quality and working conditions for the employees.

- These sensors include:
- Temperature sensors (manufacturing process)
 - Carbon emission sensors (manufacturing process, environmental emission)
 - Humidity sensors (storage/warehouse conditions)
 - Noise sensors (worker conditions, compliance)
 - Vibration sensors (machine monitoring)
 - Micro sensors and equipment tags (manufacturing process, machine monitoring)
 - Occupancy sensors (resource management, workers’ safety)
- Typical occupancy sensors include: / Passive infrared sensors (pir) / Ultrasonic sensors / Microwave sensors / Motion sensors (workers’ safety) / Fire and smoke sensors (workers’ safety, machine monitoring)

CHOOSING THE RIGHT IOT PLATFORM

The gap between the device sensors and data networks is bridged using an IoT platform with the help of back-end applications to manage the data generated by hundreds of sensors. Choosing the right platform can be challenging as there are many device clouds in the market today which are often classified as IoT platforms.

WEB AND MOBILE APPLICATION

This is an intelligent dashboard that is the part of the system most visible to you and gives you direct access to information as well as analytics, graphs, and historical data. Mobile applications give you real-time updates by means of alerts and notifications, and with smart sensors you can send commands back to the devices to remotely operate them. This makes it extremely easy for you to maintain your policies and compliance standards.

THE IOT-ENABLED SMART FACTORY

To complete the picture, we will describe a working factory featuring all the advanced components of IoT. A smart factory leveraging IoT will install multiple sensors to detect temperature, humidity, noise, light, vibrations and volatile organic compounds in its factory. The factory also has specialized sensors to track the working of all of its machines and equipment, to identify the location of vehicles which carry raw materials and finished goods as well as to manage the supply chain.

The data collected by all these sensors is transmitted to a cloud-based storage system. There, principles of data science are applied in order to get meaningful information and gain insights that are presented in the form of interactive reports and charts. Managers and other authorized employees access these data visualizations from the cloud to supervise and manage the working of their respective departments.

This information is used to maintain the right temperature, humidity, light and noise levels in the manufacturing unit, along with ensuring compliance with safety standards. The IoT and data science ensure that any defects are detected in the early stages and downtime can be prevented, and the machinery is easily monitored and maintained if faults are detected.

Vehicles are monitored in real-time to ensure that the finished goods are delivered to distributors and retailers on time. Employees are made aware of the arrival of raw materials well in advance and are prepared to start production right away in order to avoid wasting time. New or alternative routes are suggested to drivers in order to ensure that they reach their destination without wasting time and fuel.

Managing the inventory is easy for the manufacturer, as they know exactly when to order required raw materials just in time, avoiding costs for storing goods any longer than necessary. Low stock will trigger order reminders to avoid delays in the production of goods. IoT also connects the factory to warehouses, distribution centers, retailers, suppliers and customers to facilitate supply chain management by allowing real-time information sharing.

The smart factory successfully lowers costs by avoiding fuel and power wastage. Downtime is decreased to a great extent, allowing uninterrupted production in the manufacturing unit. Moreover, sensors installed on the finished goods help identify faults in products, so that they can be rectified as soon as they are detected to decrease losses and offer quality products and services to consumers. The factory also saves on warranty management.



CONCLUSION

IoT is a driving force for manufacturers today. Newark can be your technology partner and help you stay ahead of your competition in this fourth industrial revolution. With advancement in smart sensors and cloud technologies, companies can enjoy more intelligent service at a lower cost. The time is now to make your company smarter and more efficient than before. **The time is now to make your company smarter and more efficient than before.**

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