NTT DATA welcomed Dell Services into the family in 2016. Together, we offer one of the industry's most comprehensive services portfolios designed to modernize business and technology to deliver the outcomes that matter most to our clients.

The Internet of Things: Driving Next-Generation Manufacturing

Introduction

Manufacturing has evolved substantially since the Industrial Revolution. And it continues to advance today with innovations from the Internet of Things (IoT). In fact, with the infusion and integration of IoT-enabled sensors and programmable logic controllers (PLCs), smart manufacturing is completely transforming traditional manufacturing processes, with many discrete manufacturers carrying out proofs of concept and implementing IoT technologies in their plants to drive benefits.

However, manufacturers are finding that these new IoT-enabled systems remain largely disconnected from the IT infrastructure and networks used in their silos, and are facing various challenges, such as:

- Complex process and assembly lines
- Connectivity issues in manufacturing systems
- Insecure remote access and security threats
- Openness and data standard models

In order to bring about the next generation of manufacturing, IT and operational technology (OT) need to be combined for all manufacturing business processes. This white paper explores how IoT, in conjunction with network-enhanced security and analytics, is driving the future of manufacturing.

Integrating IT and OT

When it comes to IT and OT in manufacturing, their uses couldn't be any more different.

For example, small instruments (such as sensors) and associated monitoring frameworks have long gathered data about OT (such as machines and critical infrastructure) that has primarily been used for reactive purposes. On the other hand, IT has embraced data from new digital technologies (such as the cloud, mobility, analytics and social media) for proactive purposes.

However, in the era of IoT, this disparate data can be combined, with operational data being put to use through integration with IT systems.

IoT in manufacturing means that a set of machines can be integrated with sensors and actuators via PLC logic, connected to a manufacturing execution system (MES), and then connected to the intranet and the internet to share information securely within an enterprise. This means that bi-directional data can be shared between the machinery and the shop-floor managers, and even to the products themselves, which could be embedded with sensors to create smart products that help improve customers' lives.

Additionally, IoT sensors, cameras, gauges and software can be attached to the machinery to analyze the data being collected, which maintenance teams can use to keep tabs on the manufacturing process without being on the shop floor. These smart devices can also send alerts on issues — such as connectivity, potential machine failures, or altered equipment behavior due to changes in pressure, temperature, humidity, vacuum or vibration — helping ensure right-on-time maintenance with minimal (or zero) downtime and saving millions of dollars.

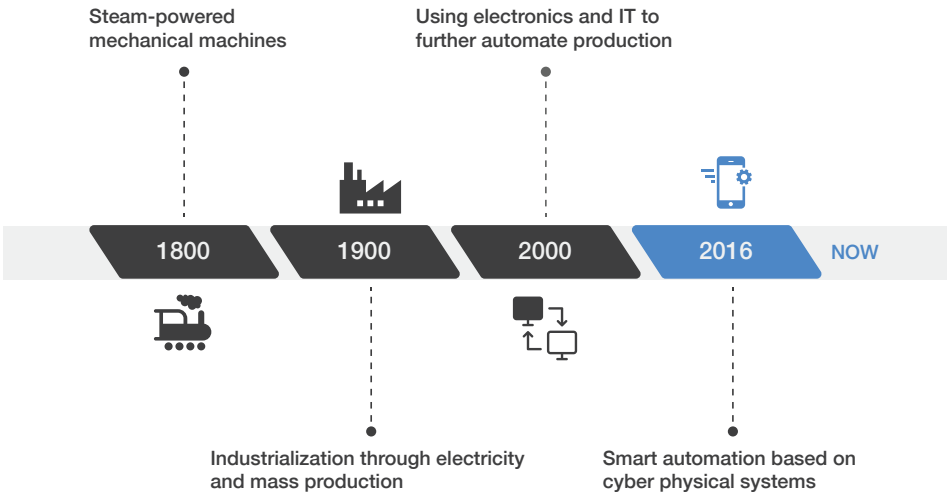

Figure 1: Manufacturing — from Industry 1.0 to 4.0

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Benefits of adopting IoT

Lower cost of ownership

With their subscription-based models, cloud-based platforms such as ThingWorx, GE Predix and the Microsoft Azure IoT Suite have brought down the cost of ownership for IoT solutions. That means small and medium businesses can now afford to enhance their manufacturing processes with IoT — something that, previously, only large manufacturing enterprises were able to do.

Improve quality

The growth of IoT on the consumer side has driven down the costs of industrial-standard sensors, controllers and networks, making it easier to embed IoT-connected sensors across the whole range of manufacturing equipment and even in new areas that have not seen heavy investment in automation, such as balance-of-plant equipment and supply chain logistics. As discussed in "Integrating IT and OT," these sensors collect data that can be used by factory floor workers, plant managers, software systems and many aspects of the supply chain to fine-tune machine configurations and subassembly lines. This helps improve the quality of products that reach customers, which ultimately builds customer loyalty and improves the relationships between manufacturing, sales and distribution.

People	Process	Data
IoT enables views of back-end and front-end factory operations.	IoT solutions are deployed by manufacturing companies through third-party platforms to improve visibility into factory assembly lines, security systems and the supply chain.	These devices and sensors generate new types of data, which helps in understanding and improving: • How machines work • What parts bring longevity to the machines and the investment • The customer experience
IoT-enabled devices and sensors provide the right set of data to the right audience beyond the organization, including raw material suppliers, partners, supply chain, marketing and consumers.	As IoT becomes more prevalent, it allows faster data flows, enabling better and quick decisions, as well as lean operations, by integrating this data into an MES.	Terabytes of structured and non-structured data will be generated through device-to-device communication, sensor communication, and rich media such as audio and video from cameras.
Manufacturing shop-floor managers have data on hand to make better decisions on production, machine efficiency, dashboards and alerts from all assembly lines.	Next-gen software-defined networks (SDNs) enable better communication and decision making between machines, allowing for self-learning automations.	This data will be subjected to analysis through advanced analytics and will be able to predict recommendations for customers and machines to make decisions at the right time.

Figure 2: NTT DATA's business-first approach to IoT

Data from IoT-connected sensors can be used to fine-tune machine configurations and subassembly lines to improve the quality of products that reach customers.

Enhance the shop floor

The IoT-enabled sensors and devices in the assembly line, integrated into the MES, provide real-time data on the machines' state, production efficiency, production line status and dashboards. This data, available at any location through the MES, helps the leadership — from the chief experience officer to the shop-floor supervisors — make the right decisions at the right time, as well as to engage manufacturers, the supply chain and suppliers. The data can also help tie the manufacturing ecosystem together, as shown in Figure 3.

Figure 3: IoT data through an MES

Additionally, having all devices connected to an IP network connects all manufacturing units across the world, which helps manufacturers to optimize and automate the shop floors, with only minimal people running the production systems. And this gets further enhanced with new technologies such as SDNs. In the near future, machines will communicate with and monitor other machines, as well as align to different product manufacturing requirements. These automated processes may trigger raw material requirements, changeover to produce different products and smooth out manufacturing processes.

Fine-tune maintenance

While manufacturing has its own processes for regular maintenance, manufacturers are typically at a loss if there is an untimely machine breakdown or any parametric changes that could result in low-quality products. Once implemented, IoT-enabled devices can provide continuous monitoring of the machinery, and predict and carry out maintenance based on historical data. This helps increase machinery uptime and enhance product quality by ensuring production parameters, such as vibrations, noise, temperature, humidity, vacuum and pressure, are set correctly.

Boost energy efficiency

Energy is one of the most important facets of manufacturing, and it has a significant influence on costs. Effective energy management can typically improve savings depending on what manufacturing setup is in operation. Most manufacturing companies lack vision in implementing IoT-based devices to optimize energy usage, which affects their manufacturing machinery, facilities and supply chains. But greater savings can be achieved by optimizing just a couple of systems. For example, integrating motion-sensor-based lights, basing temperature controls on weather and shift timings, and centralizing command for the lighting and HVAC systems will help manufacturers lower expenses and optimize energy usage.

Optimize the supply chain

Data provided by IoT devices enable manufacturers to build predictive models for their different products' raw material requirements, and improve knowledge of their supply chain partners' delivery challenges. For example, data on parameters such as dependencies, material utilization, inflows from suppliers, and manufacturing cycle time allows suppliers and supply chain partners to work toward right-on-time manufacturing. This data can also be used to track inventory levels, location, production rate and the delivery of finished products, as well as optimize inventory and capital costs.

Challenges of adopting IoT

Security

Security can prove to be a challenge when implementing IoT across the manufacturing landscape. Devices that fall on the IT side are protected by encryption as well as physical and network security. But devices that fall under OT don't have a similar level of security infrastructure. OT systems will need to implement user-level authentication and identity systems to remain secure and avoid incidents such as machinery breakdowns due to malware being downloaded from insecure remote access.

Software and protocols

IoT comprises both IT and OT systems, which have differentiated data sets. The analytical systems need to understand all kinds of data sets — such as data from PLC logic and computer numeric control (CNC) machines — to build models that can translate into actionable information for the manufacturing ecosystem, such as measuring and controlling instruments, safety sensors and the MES. That means, to make the right decisions, the analytical systems need to have the right software for correlated statistical models. And when having to accommodate more and more protocols, such as the following, this proves to be even more challenging:

- Infrastructure — IPv6 over low-power wireless personal area network (6LoWPAN), IPv4/IPv6, RPL
- Identification — Electronic Product Code (EPC), ucode, IPv6, Uniform Resource Identifiers (URIs)
- Communications/Transport — WiFi, Bluetooth, low-power wide area network (LPWAN)
- Discovery — Physical web, multicast DNS, DNS Service Discovery (DNS-SD)
- Data protocols — MQ Telemetry Transport (MQTT), Constrained Application Protocol (CoAP), Advanced Message Queuing Protocol (AMQP), WebSocket, Node
- Device management — Technical Report 069 (TR-069), Open Mobile Alliance Device Management (OMA-DM)
- Semantic — JSON for Linked Data (JSON-LD), Web Thing Model
- Multilayer frameworks — AllJoyn, IoTivity, Weave, HomeKit

Conclusion

IoT technologies are revolutionizing how manufacturers operate and are helping bring about the next generation of manufacturing. Billions of IoT-enabled sensors, gauges and cameras are generating terabytes of data, which can provide meaningful directions and insights through predictive and prescriptive analytics. The key to attaining next-generation manufacturing is embracing and using these IoT-derived insights to improve manufacturing processes, product quality and operational efficiency, while ensuring timely maintenance.