# **Things** you should know about The Industrial Internet of **Things** (Industrial IoT)

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## Summary

Whether you call it the Industrial Internet of Things (Industrial IoT), Industry 4.0, the Smart Factory, or even the Industrial Internet, the concept of using information technology and internet infrastructure in industrial applications to improve efficiencies is NOT new – particularly in the process industries served by ANDRITZ AUTOMATION.

What IS new is the access to technologies that permit direct data access from field instruments to the cloud environment, enable cloud computation and applications, have the ability to analyze BigData, and facilitate machine-to-machine communications. These technologies require successfully bridging the gap between Information Technology (IT) and Operation Technology (OT) offerings to gain competitive advantage.

It appears that companies have big ROI expectations with limited knowledge of technical issues and offerings of industrial IoT. According to a study published by MPI group [2], roughly 63% of manufacturers believe that adopting industrial IoT technology will increase profitability over the next five years. Therefore, 67% of manufacturers are expecting to increase investments in industrial IoT in the next two years. However, 67% of participants in this study have no or limited company-wide understanding of the industrial IoT concept.

Learning and understanding industrial IoT technology can be challenging due to the lack of standardization. Take the basic term “Industrial IoT Platform” as an example. A network infrastructure provider with an IT background has a different definition of this term than does a control system vendor. Process industry businesses can benefit by adopting industrial IoT technology despite the fact that, until today, there has not been a tangible study to estimate the actual ROI. Therefore, increasing the knowledge and providing company-wide education is essential for a successful investment.

This paper provides fundamental information about industrial IoT technology and offers an explanation of some new and associated concepts.

### Notations

- IoT Internet of Things
- IIoT Industrial Internet of Things
- IT Information Technology
- OT Operation Technology

### Keywords

Industrial Internet of Things (Industrial IoT), Industry 4.0, Industrial Internet; remote control and remote operation, autonomous plant

# Contents

## Revolution or Evolution?

Industry 4.0 started as a European initiative to safeguard a sustainable advantage for manufacturing companies to remain globally competitive. A closely related concept is the Industrial Internet of Things (industrial IoT) which has many variations – from GE's "Industrial Internet" to Cisco Systems' "Internet of Everything."

From a process plant's perspective, the technologies in play here are not new. Industrial IoT can be characterized as an evolution (not a revolution) that is driven by innovative combinations of these technologies.

What IS new in this area is the massive increase in computer performance (more computing power in smaller packages) and the utilization of the cloud environment. Technologies can be linked and very large volumes of data (Big Data) can be analyzed and understood to considerable benefit.

In 2015, Accenture [1] predicted that, by 2030, the value of industrial IoT businesses will grow to approximately US$ 10.1 trillion in the USA, China, Germany, and the UK combined. This number is arrived at by estimating the uplifting effect of industrial IoT on the GDP in those countries.

Despite the bright predicted future and various investments in this field, comprehensive solutions forindustrial IoT technology are lacking, but the landscape of the businesses and vendors offering solutions in the industrial IoT field is vast. Companies are extending their existing solutions to address the industrial IoT infrastructure needs in networking, analytics, applications, and platforms.

This paper aims to address and answer the following questions:

- If the industrial IoT concept has been in practice for many years by process industries, then what is the origin of the new found excitement?
- If industrial IoT is just another buzzword and perhaps hype, then how do we explain the momentum and enormous investments made by giant corporations such as IBM and GE?
- If industrial IoT is more than hype, then what are its new offerings and promises – especially for process industries?
- What are the implementation challenges and expected return on investment for industrial IoT?

Understanding industrial IoT technology is almost impossible without understanding two abbreviations that are frequently used in this field: IT & OT

- **Information Technology (IT).** Information Technology companies such as Google, IBM, and Intel have a long history in managing data and providing applications to analyze them.

- **Operation Technology (OT).** Operation Technology companies such as Rockwell Automation, Emerson, and Honeywell are the ones who provide control systems and related network architecture and software for process industries.

Some IT companies are starting to penetrate into process industries as data connectivity consultants by bringing their solutions for data handling and analytics. These companies are the driving force behind the Internet of Things (IoT) and consider industrial IoT as a subset of IoT. It is their belief that since IoT represents a "revolution" in the connectivity of smart devices (e.g., smartphones, smart appliances, smart homes, smart cities, etc.) which have changed our lives forever, then industrial IoT is also a revolution.

These IT companies are providing industrial IoT platforms to address interoperability issues. One issue is communication between platforms that were created for different business purposes (e.g., communications between a weather network information infrastructure and the supervisory layer of a process control network).

Most of the OT companies, who have been providing data connectivity and control networks to process industries for many years, have adopted the “evolutionary” school of thought. The structure and technology of collecting data from the field and storing and analyzing it on servers is evolving to accommodate faster transfers and significantly larger volumes of data gathered from industrial processes. These companies are evolving their products to comply with IoT requirements and address new needs.

Conclusion:
Regardless of which view a person subscribes to -- evolutionary or revolutionary – it is clear that industrial IoT has a lot to offer for process industries. industrial IoT technologies and concepts can improve the data network architecture, increase production efficiency, and reduce operating costs through various means.

## IoT vs. Industrial IoT

Pioneering IT companies consider the Internet of Things to be the big umbrella that promises continuous data connectivity and communication between smart things – regardless of the variety of the smart things, the size of data, and the sampling frequency. IoT technologies are being designed to provide reliable data analytics to extract key information from large volumes of data (a.k.a Big Data analysis). However, IoT is not just for analyzing and visualizing Big Data. Cloud platforms (which will be discussed later), improved communication networks, and new protocols are also inseparable parts of IoT.

Most IT companies consider industrial control components (sensors, actuators, controllers) as being similar to other smart devices (like a smart appliance would be to a smartphone). In their view, industrial IoT is deemed a subset of IoT.

Viewed from another perspective, the things in industrial IoT are considered to be fundamentally different from the things in IoT. When the criticality of the things in industrial IoT is considered, industrial IoT is viewed as being separate and independent from IoT. For example, Profinet [3] summarized the differences between IoT and industrial IoT in process industries (*Figure 1*), which illustrates the two different viewpoints of IoT and industrial IoT.

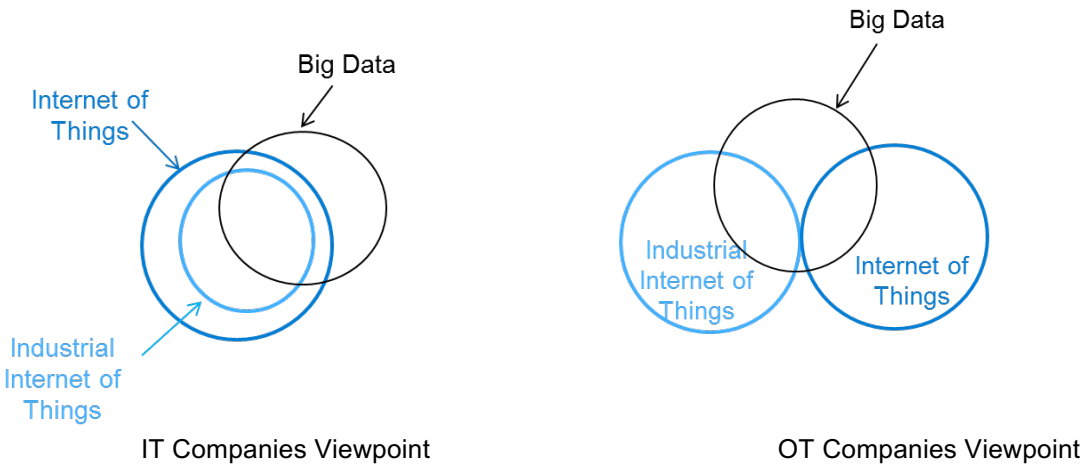



***Figure 1: IoT vs. Industrial IoT***

## Industrial IoT benefits

A recent study [5] shows that 62% of the 300 companies responding a survey have difficulty building a strong business case to approve funding for their Industrial IoT projects. Therefore, understanding the potential economic benefits of adopting an Industrial IoT strategy and migrating to an Industrial IoT structure is key. Some of these benefits are summarized below.

### Decreased Operating Costs

Migrating to an Industrial IoT structure in a brownfield plant requires a capital investment, but ultimately leads to decreased operating costs. It also reduces future upgrade and migration costs.

- **Lower IT costs:** Migrating to cloud computing and using a cloud infrastructure eliminates the need for local expensive IT hardware and servers. Also, fewer IT professionals are needed to monitor the infrastructure 24/7, and a lower number of local resources are required to maintain an acceptable level of IT services and cybersecurity. It should be noted that the cybersecurity is still an on-going concern for Industrial IoT technology. This will be discussed in more details later.

- **Reduced costs for applications and software:** Traditionally a premium price had to be paid for the OT vendors' software for historizing and analyzing data. With the various software toolboxes provided by IT companies, plants can lower software and associated costs for storing and analyzing plant data.

- **Lower licensing costs:** The price of many OT software offerings is based on the number of tags being processed or historized. These licensing costs often force process industries to dramatically reduce the data volume. With direct data communications outside the control network, plants can aggregate and process an unlimited amount of data without increasing licensing costs.

- **Lower administrative costs:** Industrial IoT platforms provide a higher level of automation in data handling and decrease the need for professional interactions. In a study done by Cisco Jasper [6], it was shown that utilizing Industrial IoT can result in US $ 1.2 million savings in data administration costs for a company with 100,000 devices.

- **Remote monitoring and operation:** Remote operation can decrease operational costs by reducing the headcount and increasing efficiency. The Industrial IoT architecture facilitates the migration toward remote monitoring and operation. An immediate side benefit of the Industrial IoT investment is decreasing the cost of migrating to remote operations.

- **Autonomous operation:** Considering the information and technologies made available by Industrial IoT, the next step forward for process industries is to move toward autonomous operation. Using real-time analytics, integrated M2M communications, and smart sensors and actuators, the need for human interaction at the basic decision-making levels is decreasing. This directly reduces the cost of human resources for basic operations.

### Increased Efficiency and Productivity

- **Big Data analytics and data mining:** This concept is the biggest and most significant advantage of Industrial IoT technology. By aggregating data in one place and utilizing the almost unlimited computational power, companies can perform Big Data data analytics to manage volume, velocity, and variety. Data mining techniques are used to extract key performances indices from raw data. High computational power also enables reliable condition monitoring and asset management in real-time. Companies can optimize their operation based on the data acquired

from customers, financial institutions, stock markets, supply chain, weather forecasts, videos and pictures, etc.

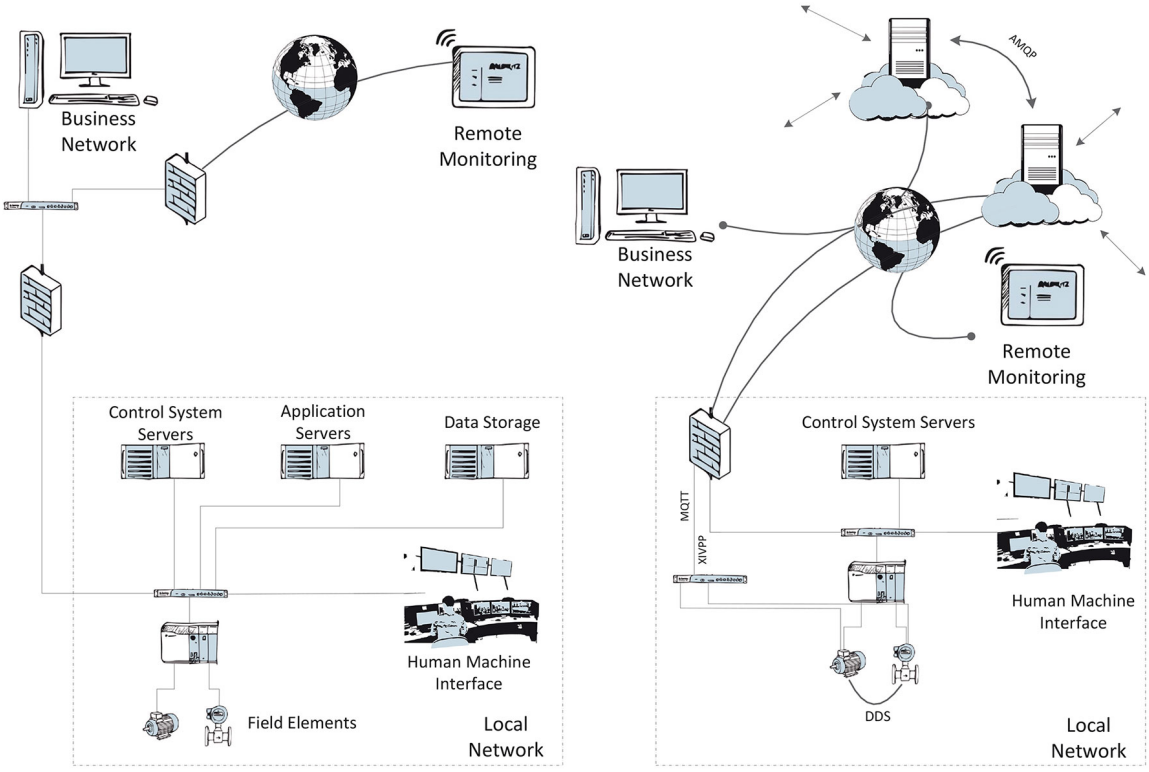
- **IT uptime:** Moving to the cloud environment increases the availability and reliability of IT-related processes.

- **Data accessibility:** Using a cloud environment gives operational managers and executive leaders access to key performance indices faster and easier. It also allows vendors and suppliers to connect to their clients through web applications in real-time. For many industrial applications, this remote data accessibility enables remote monitoring and control of operations, or remote management decisions for operations that are largely autonomously controlled.

- **New applications and scalability:** There is a tremendous momentum among cloud application developers to create useful applications on Industrial IoT Platforms. Process industries are no longer bound to OT companies for their applications and software. They can take advantage of open-source products and vast user communities which participate in knowledge sharing. As an example, companies can use available social media APIs and applications for their marketing campaigns or use stock market data for on-going optimization. The Industrial IoT structure is inherently scalable which is an important consideration for any company's expansion plans.

## Industrial IoT Architecture for Process Industries

A simplified control/information network in a medium-sized process plant is shown in *Figure 2*a. The network infrastructure consists of various layers. Usually, the control network is the inner layer and the business network is the outer layer. Data communications is through conventional protocols (e.g. HART, OPC, etc.). There are firewalls and demilitarized zones to enhance security and allow remote data access. Traditionally, the data is stored and analyzed on local servers. OT companies provide most of the software. The number of tags is usually the driving force for the licenses. The controls, HMI, data visualizations, and data analytics are mostly accommodated through control systems (PLC, DCS) or related servers.




**a) Conventional Control Network Architecture** **b) Industrial IoT Enabled Control Network Architecture**

***Figure 2: High-level schematic for control/data network in a process plant***

*Figure 2*b illustrates a simplified control/information structure with the industrial IoT concept for process industries. There are important differences in the industrial IoT control architecture compared to a conventional control network: usage of the cloud environment, additional data communication protocols, additional smart field elements, machine-to-machine communications, and on-the-edge analytics.

## Cloud Storage and Computing

Instead of storing data locally and performing data analytics using local resources, in the industrial IoT structure the data is transferred, monitored, analyzed, and stored in the cloud environment. There are many commercial clouds available to choose from, or companies can design and implement their own private clouds. Many cloud platforms have been developed for IoT, and some of them are becoming more standard for industrial IoT. However, this development is still at the first stages of standardization.

The purpose of a cloud platform (a.k.a. Industrial IoT Platform) is to separate the cloud infrastructure from the applications executed on the platform. Migrating to a cloud environment has the following benefits:

- **Scalability.** Computing power and storage are easily scalable in the cloud environment. This allows cost-effective and efficient provisioning of resources. Often, substantial computing power can be rented on demand.

- **Security.** Instead of hiring IT security experts for each plant and organization, process industries can rely on the security provided by the cloud service providers. Giant cloud providers have the capacity to hire diversified security experts who are able to utilize many different strategies and methods that might be very costly for a single company.

- **Interoperability.** The applications executed on one cloud platform must be able to communicate with other applications possibly run on different cloud platforms. Cloud applications can use data from various sources (e.g. industrial data, business data, environmental data, etc.).

- **Availability and Reliability.** The cloud infrastructure is designed to be highly redundant, and the cloud service providers are specialized in monitoring and maintaining their systems. Therefore, the cloud environment is more reliable than a poorly maintained local IT infrastructure. Usually, cloud service providers have multiple data centers around the globe which results in higher availability rate and geographical redundancy.

## Protocols

New protocols are being utilized to fully unlock the potential of the industrial IoT concept. These protocols allow applications to take advantage of the enormous amount of data from various sources. Some of these protocols originated from OT companies, and others have been used in the IT world, primarily adapted from other applications. For example:

- Protocols introduced for industrial IoT with OT origin:
    - OPC UA: OLE for Process Control (OPC) Foundation has extended its protocol to accommodate the needs of a reliable industrial IoT system by developing OPC Unified Architecture (UA) protocol.
    - DDS: Data Distribution Service for real-time systems is a machine-to-machine protocol which enables direct communication between smart devices.

- Protocols introduced for industrial IoT with IT origin:
    - MQTT: Message Queue Telemetry Transport protocol is a publish/subscribe protocol that connects embedded devices and networks with applications and middleware. Many industrial solutions are already using this protocol, since it is suitable for communicating a vast amount of data in real time.

- XMPP: Extensible Messaging and Presence Protocol has been used in instant messaging for multi-party chatting. Since XMPP allows messaging on internet independent of the operating systems, it has become an attractive candidate for some industrial IoT applications and equipment.
- AMQP: Advanced Message Queuing Protocol is an application-layer protocol that allows communication between applications on interoperable platforms.

## Direct Data Access

In a conventional control network, data from the field elements is gathered by the control system and is processed by monitoring servers. Later, this data is made available to other applications for further processing.

In the industrial IoT structure, field elements communicate directly with cloud applications through intelligent gateways. This reduces licensing costs significantly and allows companies to use the additional information for reliable data analysis. All the data from smart sensors can be stored in the cloud without flooding the mission critical control systems.

## Additional Field Elements

Traditionally, process industries have been mindful of the costs associated with additional sensors and other field elements. Today, there are very inexpensive sensors on the market that can be used in various control/monitoring strategies. While it is true that the manufacturers of inexpensive sensors have been known to compromise the accuracy of their products in comparison with their more expensive counterparts, it is possible for an industrial plant to use multiple inexpensive sensors in an Industrial IoT strategy to measure one characteristic of their process. Integrating data from the multiple sensors and using data analytics allow plants to decrease their overall measurement and monitoring costs.

## On-the-edge Analytics

The concept of analyzing data and extracting more information from smart devices, before the data reaches the control systems or the cloud, is now possible when using smart gateways. The importance of this technology becomes evident when direct machine-to-machine (M2M) communications for smart devices is considered. Consider M2M applications in the shipping/receiving area of a process plant. Many of these steps can be automated by enabling direct communication between various machines. D. Evans from CISCO, [4] says that, by 2020, 45% of all internet traffic will be M2M communications.

## The Technical Challenges of Industrial IoT

Technical challenges are always expected when adopting a new technology or concept. The adoption of an Industrial IoT is no exception. According to a recent survey [5], the absence of solid understanding about Industrial IoT offerings, security concerns, lack of standards, and not having the right technology partner are among the most important challenges that companies face.

Cybersecurity is an on-going concern. Since Industrial IoT technology enables the direct connection of smart control elements to the cloud, security vulnerability can increase. There are several studies to address these concerns [7] and mitigate the risks. An advantage is that cloud providers extensively invest in their cybersecurity, employing extensive resources to address this issue compared to an isolated company. Therefore, aggregating the data and core business platform in the cloud can decrease cybersecurity costs and concerns for such companies.

The lack of standardization is another challenge in any Industrial IoT project. There is no single comprehensive solution provided by a single vendor. Each major technology provider has its own interpretation of Industrial IoT concepts. This emphasizes the importance of a competent advisor and integrator -- knowledgeable and up-to-date on Industrial IoT concepts and the available technologies. Such integrators play a crucial role in a successful implementation of an Industrial IoT project.

## Conclusion

This paper has attempted to provide an overview of the main benefits, risks, and issues that Industrial IoT technology brings to the traditional control/data architecture in process industries. Implementing direct data access from field instruments to the cloud environment, cloud computation and applications, Big Data analytics, and machine-to-machine communications will help process companies gain a competitive edge. A successful Industrial IoT implementation requires bridging the gap between IT and OT offerings.

Since adopting or migrating to an Industrial IoT solution requires capital investments, industrial plant owners will likely consider conducting Industrial IoT projects in a gradual manner, starting with areas that provide the highest ROI (such as asset condition monitoring and performance optimization). The existing information/control system can be retained so that it runs alongside the new architecture that gathers data from a variety of sources to increase operational efficiency and reduce costs.

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# About ANDRITZ AUTOMATION

As a vendor-neutral solutions supplier, ANDRITZ AUTOMATION has invested in understanding the features, benefits, strengths, and weaknesses of different IT and OT suppliers’ technologies. It then integrates the most appropriate and cost-effective technologies from the suppliers. Therefore, it can serve as an advisor and integrator, capable of providing an objective view about the technologies relevant to process industries.

More than 2,000 ANDRITZ employees worldwide develop automation solutions and products for digitization and networking of systems and components. ANDRITZ AUTOMATION helps industrial facilities around the world to realize their full potential by maximizing output, minimizing costs, and optimizing operations. The experienced ANDRITZ AUTOMATION team focuses on the design of electrical, control, and instrumentation systems, drawing on some of the world’s leading simulation, advanced process control, and operator training tools.

Metris – a new technology brand for Industrial IoT solutions which is the combination of ANDRITZ expertise, technologies and products. Technologically, Metris is based on the three pillars Smart Sensors, Big Data Analytics and Augmented Reality: These technologies are arranged and adapted individually to meet the requirements of every single customer – exploiting the capabilities of systems already installed and measurably enhancing plant performance and profitability.

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