IXON

The Road to IIoT Maturity in Machine Manufacturing

Exploring the technological developments that make our machines smarter

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Introduction

The machine building industry is in the middle of an industrial revolution.

Smart Industry and Industry 4.0 mark the era in which industries are constantly shifting towards the latest technologies. Companies now need to focus on their digital transformation to stand out from their competitors.

By equipping machines with sensors, software and other smart devices and connecting them to the internet we are able to monitor and manage them from a distance.

These connected machines form the Industrial Internet of Things (IIoT). The driving idea behind IIoT is that smart machines are better than humans at accurately and consistently capturing and communicating real-time data. Captured data, usually stored in a cloud environment, allows for great improvement in machine efficiency and offers machine builders the opportunity to think of new business and service models for their machines.

There is still much to gain within the field of IIoT. Even though many machine builders already deploy remote access to their machines, most machines still lack an architecture or strategy for data capturing and storage.

Machine builders who do gather data often fail to actively convert the enormous amounts into actionable information which can be used to improve business decisions.

However, innovation is hard to achieve. You, or your customer, need to see the added value before adopting new practices. Game changing applications like Artificial Intelligence and machine learning need new innovative technologies, and to keep up with your competition you need to get started on your journey of implementing IIoT. But, it's not only important to keep innovating products, it's also crucial to extend the customer's satisfaction to stay relevant.

While IIoT shows great potential in generating cost savings and optimizing machine efficiency, its implementation poses some practical challenges. Since incorporating machines into IIoT requires more than just an overnight change, many machine builders ask themselves the burning question: **"What's in it for me?"**

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This white paper aims to answer that question using the Industrial IoT Maturity Model, a guideline that helps machine builders take the next step towards a fully mature IIoT implementation.

We'll explain the model in more depth in the next chapter. After, we'll take you through the various phases and how to progress along the IIoT journey – sharing relevant business cases along the way.

After reading you'll know

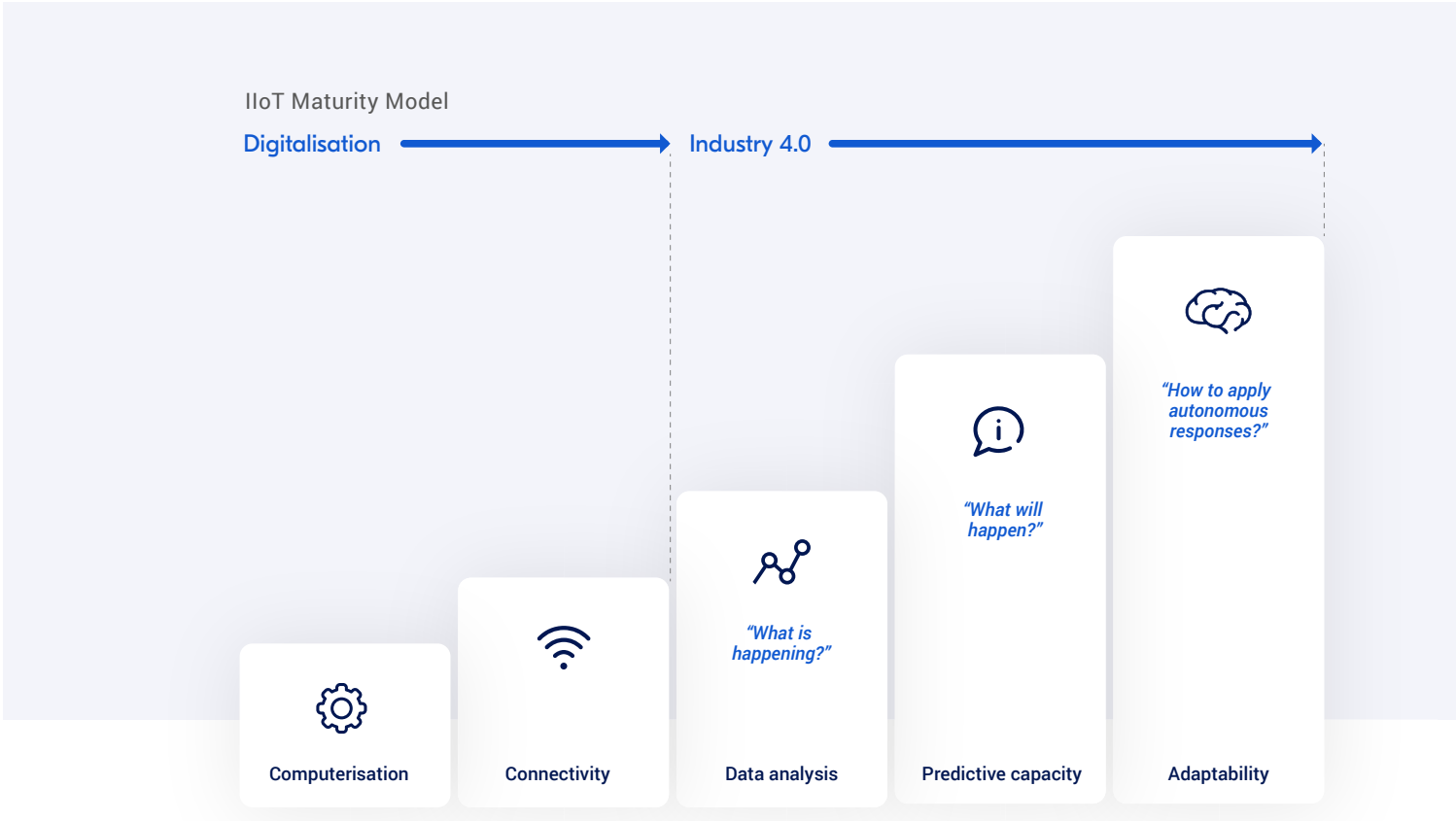
- What IIoT is and what a fully mature implementation looks like;
- Which level of IIoT maturity you are currently at;
- How to take the next steps and grow your maturity level;
- How other companies have implemented the various phases; and
- Which benefits each phase can offer you.

The Industrial IoT Maturity Model

Before we delve into all that Industrial IoT (IIoT) has to offer, we need to establish exactly what it entails.

The Industrial Internet of Things refers to the use of IoT in industrial applications, focussing on various new and innovative technologies (M2M communication, big data, machine learning, etc.) to increase efficiency and reliability of operations. Keeping up with, or staying ahead of, the competition means adapting to Industry 4.0 tactics.

The Industrial IoT Maturity Model forms the foundation of future plans for your IoT journey in the manufacturing industry. It shows the ladder from Digitalisation to Industry 4.0. In the upcoming chapters, we'll use this model to show exactly which steps you should take to further the maturity of your IIoT implementation.



A brief overview of the five phases of IIoT implementation

How mature is your IIoT implementation? Which phase are you in? And what are the next steps you can and should take? This brief overview of the five phases and their characteristics and key enablers, should help you get acquainted with the model and help you answer these questions. We'll delve further into each phase in the following chapters.

Phase	Description	Characteristics	Key enablers
Phase 1 **Computerisation**	Initial digitisation phase where machines are controlled by software.	■ Isolated PLC-controlled applications ■ Standalone machines ■ Limited functions	PLC, Sensors, RFID, Embedded units, Human Machine Interface (HMI).
Phase 2 **Connectivity**	The company has integrated some level of connectivity for remote machine access and control.	■ Connected devices ■ Secure remote management ■ Managed services through the cloud	VPN, Remote Access, Cloud.
Phase 3 **Data Analysis**	A clear strategy is set out to collect and analyse data for the improvement of the organisation and/or product.	■ Lightweight data transfer & data storage ■ Historical machine insights ■ Production- and management-steering information	Data integrations, MQTT, Cloud storage, Dashboards, Visualisation.
Phase 4 **Predictive Capacity**	Sophisticated analytics and consistent operationalising by means of best-practice patterns.	■ Smart functionalities ■ Applying contextual analytics ■ Pro-active servicing	Alarms, Preventive notifications, Predictive maintenance.
Phase 5 **Adaptability**	Integrated platforms and unified technical stack with intelligent capabilities.	■ Integrations with other solutions ■ Converged tech ■ Intelligent solutions for autonomous responses	APIs, Web services, Machine learning, Artificial Intelligence.

Computerisation and Connectivity

Remote control is one of the most important mechanisms for increasing machine efficiency and reducing costs for service trips.

The initial phases of the Industrial IoT Maturity Model are computerisation and connectivity, collectively called digitalisation.

It starts with computerisation where machines are controlled by software. Most companies have already taken this first step towards IIoT maturity. This forms the base for connectivity, where industrial devices are connected to the internet, making it possible to remotely access your machines.

Digitalisation of industrial machines

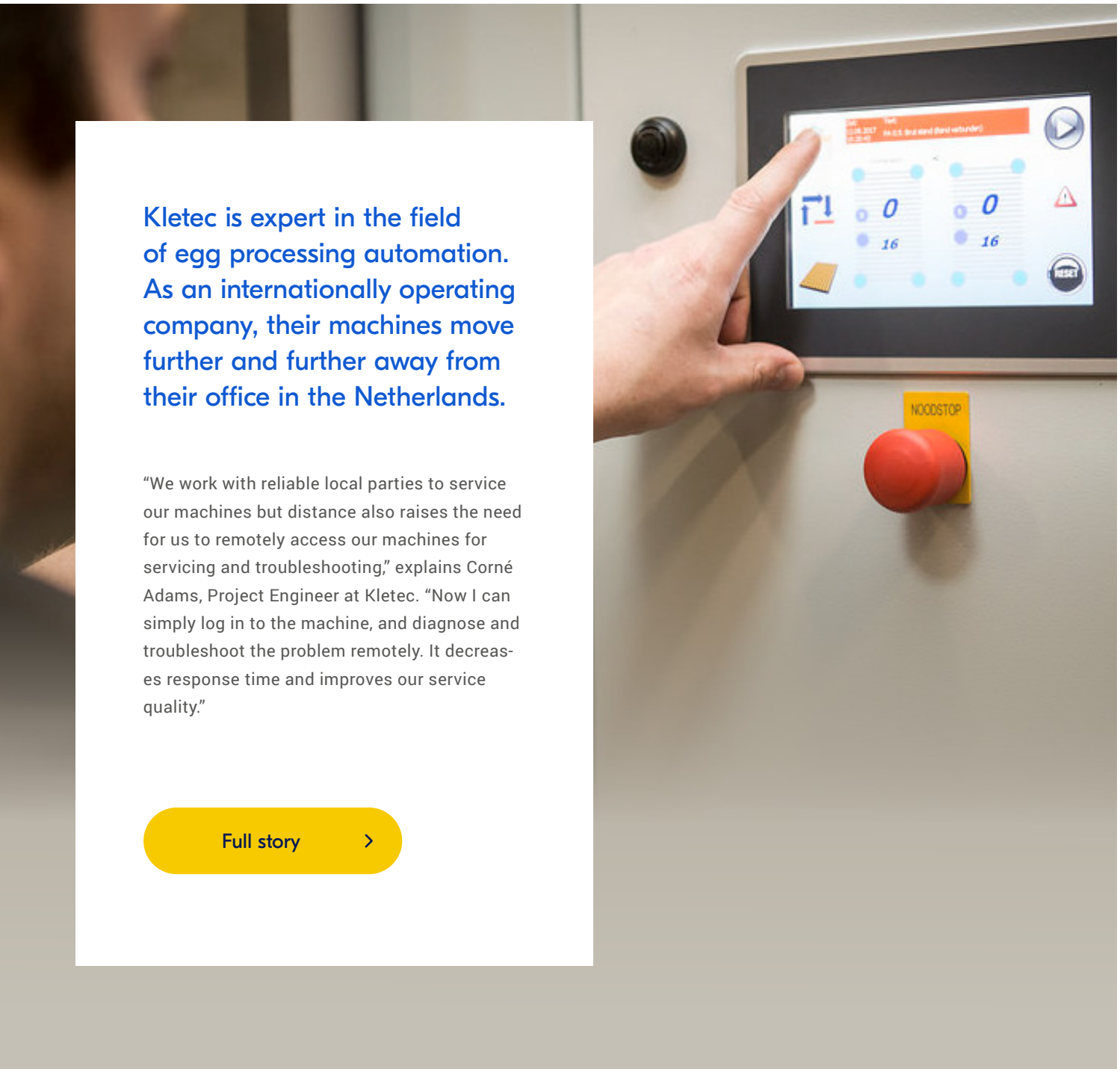
Digitalisation of industrial machines PLC's, HMI's, Industrial PC's and robotics are indispensable in the manufacturing business. The combination of computerisation and connectivity solutions has created opportunities for remotely accessing machines from anywhere, at any time. Remote control is one of the most important mechanisms for increasing machine efficiency and reducing costs for service trips.

This raises interest for implementing remote access and is also the reason why many machine builders already utilise it to their advantage.

While there are multiple ways to facilitate remote access to a machine or production plant, its basis most often comprises edge hardware, virtual private networks (VPNs) and computers. Edge hardware can be an industrial router or a gateway for example. It facilitates the communication between the local machine or plant network and the on-premises or external IIoT platform, like a cloud platform. The edge hardware or software is necessary to allow for remote access, enabling you to digitally place yourself next to your machine wherever it may be located.

Use case

Kletec diagnoses and troubleshoots problems remotely



Kletec is expert in the field of egg processing automation. As an internationally operating company, their machines move further and further away from their office in the Netherlands.

"We work with reliable local parties to service our machines but distance also raises the need for us to remotely access our machines for servicing and troubleshooting," explains Corné Adams, Project Engineer at Kletec. "Now I can simply log in to the machine, and diagnose and troubleshoot the problem remotely. It decreases response time and improves our service quality."

Full story ›

The added benefits of remote access

The ability to use the internet to access connected machines leads to significantly reduced service costs through remote diagnostics, troubleshooting, commissioning, and other capabilities that reduce the need to deploy field service personnel. Instead of stepping into a car or plane to get on-site, you can now simply use your smartphone, tablet or laptop to connect to your machine and start diagnosing or programming from wherever you may be. Remote access allows for faster response time to machine failure which greatly reduces machine downtime.

Security tip

Traditional solutions would open ports in the company's firewall to allow external access to machines, exposing the internal network to the internet. A secure remote access device should have a firewall that blocks all traffic from the internet to the company network – and vice versa, keeping your network isolated and safe.

Requirements to fulfill the Digitalisation maturity phases:

- ✓ Implement control equipment (PLC, HMI, sensors, etc.) to digitally control machines via software
- ✓ Set up a remote access solution to access control equipment via the internet
- ✓ Diagnose, troubleshoot, program and update software remotely

Data Analysis

Machine data forms the heart of IIoT

In this phase you're going to get a better idea of what's happening in your machines and why it's happening. A clear strategy to collect and analyse data for the improvement of your products is key for implementing IIoT.

But how do you gather data? How can you perform data analysis? And what can you achieve with your machine data?

Gather and store machine data

The application of IIoT revolutionizes the machine building industry by enabling the acquisition and accessibility of data in far greater amounts and speeds than ever before.

It's safe to say that machine data forms the heart of IIoT and the benefits that may result from it. Important insights can be gained from machine data, as long as you apply the right tools to collect, store and report this data.

It's easy to say that highly valuable insights and great efficiency improvements can follow from machine data, but where do you start? Gathering data requires the machine to be equipped with parts like sensors, controllers or actuators that are able to generate data. They are interconnected, carry out specific functions within the machine and are able to communicate with other equipment through industrial communication protocols, such as OPC-UA and Modbus. You need the right equipment to send their data to a server. Equipment that can store your machine data and/or send it to a (local or cloud) server, like a data logger, IoT device, edge gateway or industrial router.

Setting up a data monitoring strategy

With the right equipment you are now able to collect and store your data. The next important step is to think about your data strategy. You know which machine data is available, so you can best identify which data is critical for your process. This is the data you're going to monitor. See if there are any deviations, such as unusual vibrations or too much upper weight or underweight, and react to it quickly. That way you can constantly optimise your machines and your manufacturing process.

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Data analysis using an IIoT platform

There are many different data visualisation solutions available. Based on your data strategy, you know which information you want to extract from your machines. An IIoT platform will provide the tools you need to create reports with the generated machine data. Through monitoring and interpreting these reports, you can gain new insights into things like machine status, bottlenecks or error causes. Obtained machine data can provide the machine builders with priceless feedback that drives innovation for the next generation of machine design. It shows engineers precisely where to make improvements on future machines. By focussing on its core usage, machine builders can optimise machine design and reduce costs, contributing to their competitive advantage.

Security tip

Make sure that your chosen data solution partner handles your data securely. Inform about the location of the data servers, information security management systems and threat prevention measures.

Valuable machine insight reports for customers

The combination of analytics software and cloud based platforms allows you to create valuable insight reports from machine data. An added bonus is that you can use these tools to generate insights which can also be shared with end users. Your customers can have vastly different data needs than you. Think of measurements regarding Overall Equipment Effectiveness (OEE), a golden standard for measuring manufacturing productivity, how much of a certain product's been produced or the number of faulty products per production run.

From the edge to the cloud

Data generation
PLC + machine components

Data aggreration
Edge gateway

Data management
Industrial IoT platform

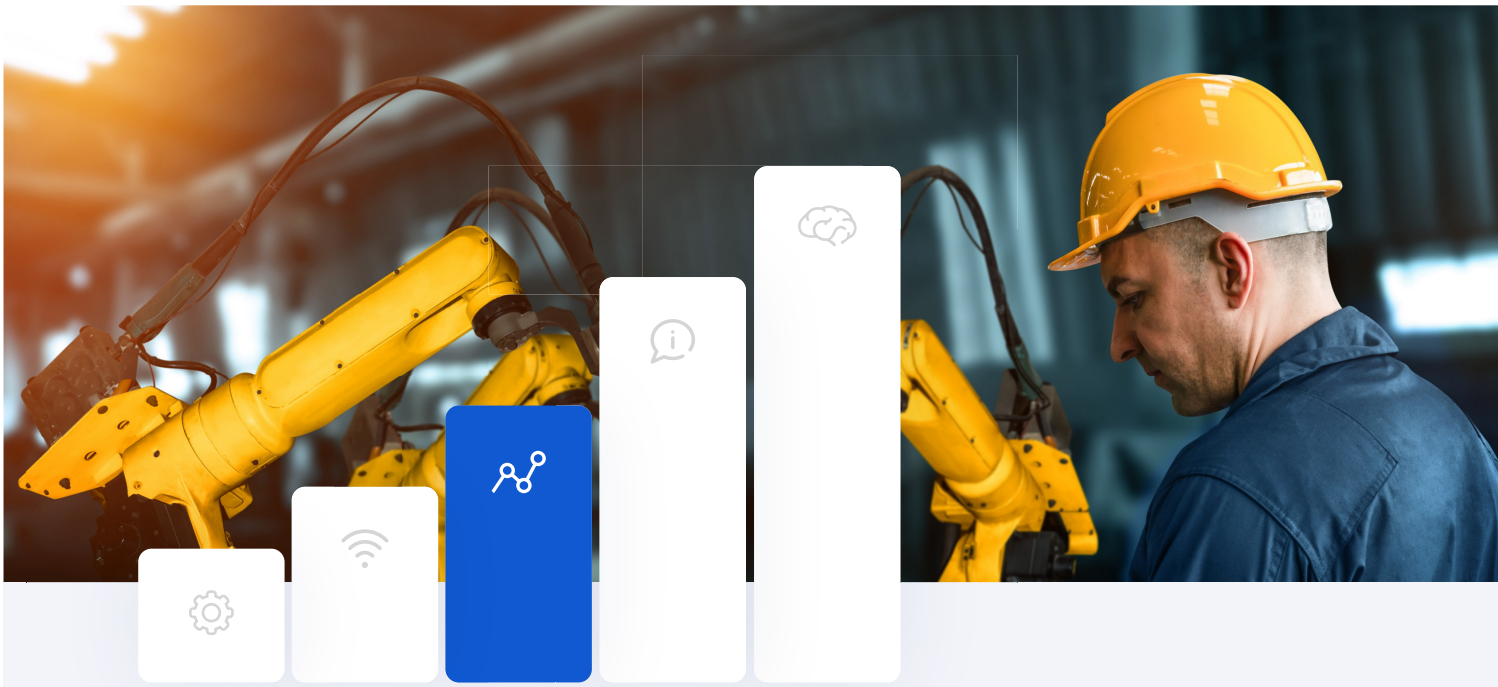
Use case

Better Origin monitors effectiveness of feeding program

Better Origin develops fully autonomous and modular insect farms that convert local waste into insect protein for animal feed.

There's virtually no data that they don't log. "This includes all the sensor data from our feed production process, all the larvae rearing data, and internal data logic flags such as system alerts and operating modes," Dave Roe, Lead Engineer at Better Origin, explains. "Because of that data, we managed to identify problems with our processes in the early stages of the larvae life cycle."

Full story ›



Requirements to fulfill the Data Analysis maturity phase:

- ✓ Create a data monitoring strategy
- ✓ Implement a data collection device
- ✓ Set up a (local or cloud) data storage solution
- ✓ Set up reports in a data visualisation tool
- ✓ Analyse data for problem detection, machine improvement and customer insights

Predictive capacity

Now that you've built up a strong foundation for data generation, storage and monitoring, it's time to increase the value of machine data by putting the generated data to use.

This next phase of the IIoT Maturity Model focuses on forecasting **what will happen** to your machines. If you know when an error or breakdown is going to occur, you can change from reactive to proactive service methods like predictive maintenance.

Predicting machine failure and breakdown

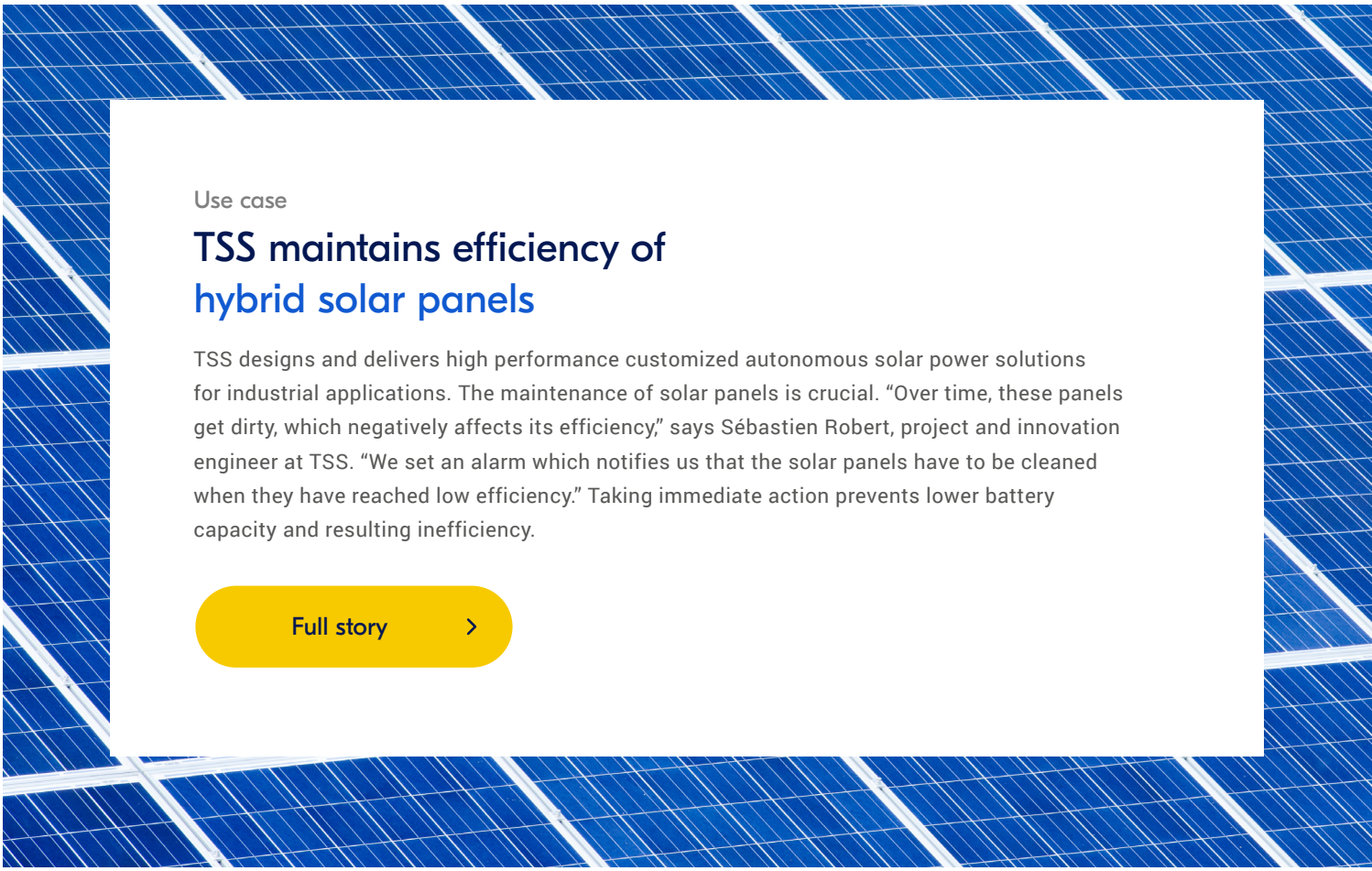
Every manufacturer has dealt with machine downtime at one point in time. Predictive maintenance helps reduce that unplanned downtime by using real-time machine data to predict machine failures before they even occur and to anticipate future developments. A study by Accenture says predictive maintenance and machine monitoring can generate savings of up to 12% on scheduled repairs, leading to a 30% reduction in maintenance costs and a 70% cut in downtime from equipment breakdowns.

Predictive maintenance and machine monitoring lead to a 30% reduction in maintenance costs

By now you should already be collecting and pre-processing your machine data. To get started with predictive capacity, you'll need advanced analytics to convert that data from raw figures into actionable information for fault detection or time to failure prediction. You then use that information to schedule maintenance and optimise resources to improve overall machine performance.

Security tip

Make sure to build redundancy in your alarming systems. You do not want to run the risk of alarms not being sent at critical moments because your system was unavailable and had no failover.



Use case

TSS maintains efficiency of hybrid solar panels

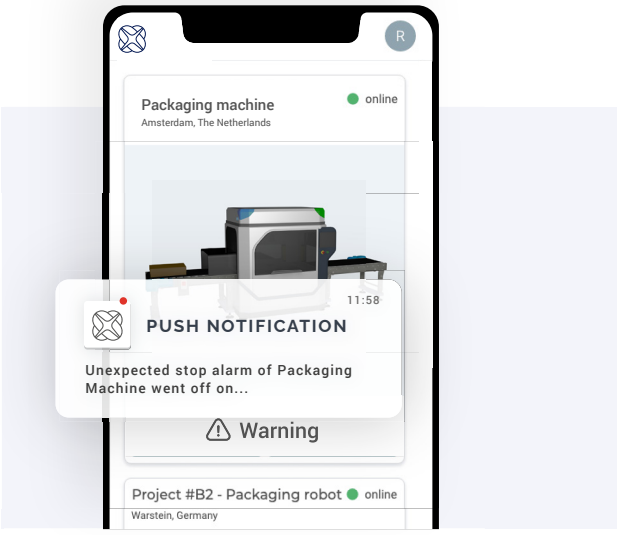
TSS designs and delivers high performance customized autonomous solar power solutions for industrial applications. The maintenance of solar panels is crucial. “Over time, these panels get dirty, which negatively affects its efficiency,” says Sébastien Robert, project and innovation engineer at TSS. “We set an alarm which notifies us that the solar panels have to be cleaned when they have reached low efficiency.” Taking immediate action prevents lower battery capacity and resulting inefficiency.

Full story ›

Set alarms and notifications

The use of alarming is already well-established in the industrial sector. However, it’s often used in a reactive capacity, meaning that you’d receive an alarm if a machine has already broken down, or if the efficiency is already down. You will then act quickly to solve the issue as soon as possible.

By combining smart devices, expert knowledge and machine data, engineers are now able to design more refined alarms that monitor more events for different purposes. For predictive capacity you change your use of alarming from reactive to proactive. With the information you’ve now learned about fault detection and time to failure prediction, you can set up alerts a certain time before a breakdown is set to happen. That leaves enough time to e.g. replace a certain part before it can cause machine failure.



Self-optimising with Artificial Intelligence

Let's go one step further. Artificial Intelligence (AI) digs through all your machine data, identifies what the tipping point is and sends you a notification.

Machine learning takes on the monitoring and alarm settings, so you can focus on other important tasks. We'll delve more into this topic in the next chapter.

Requirements to fulfill the Predictive Capacity maturity phase:

- ✓ Determine which variable indicates machine condition
- ✓ Analyse data to determine future failure point(s)
- ✓ Configure alarms to trigger ahead of time
- ✓ Perform maintenance before machine breakdown

Adaptability

By seeking collaboration between various sources of information, you can get more value out of your existing data set.

Now that you can digitally and remotely control your machines, monitor data to understand what is happening and predict what is going to happen, it's time for the last phase of the IIoT Maturity Model.

Adaptability is the most advanced, complex and innovative phase of IIoT application. It consists of two different paths: engineering and corporate.

Adaptability in engineering

In engineering adaptability, we aim to apply autonomous responses such as automated actions and automated decision making. Ticking off the previous phases is a fundamental requirement for taking this final step towards adaptability. When you've done so, you've opened the doors to a whole new set of exciting possibilities. For example, having the machine automatically change the sequence of planned orders because of expected machine failure.

Integrating smart technologies into your systems results in capabilities like machine learning and artificial intelligence.

Connected devices, services and platforms can together offer new and exciting technological advancements. Like integrating ERP and machine production data with a predictive analysis tool to gain smart machine insights.

During your journey of getting to this final phase you've most likely started using an IIoT platform. What you will come to learn during this phase is the importance of an open solution. The term "open" may cause some fear, but don't worry – in this case we're simply talking about platforms or solutions that can easily integrate with third-party applications.

By seeking collaboration between various sources of information, you can get more value out of your existing data set. It's impossible to find an all-in-one solution that successfully offers everything you need to reach this final maturity phase, as it requires so many different areas of expertise. It's the collaboration between different solutions that will lift your adaptability to higher levels, as you get maximum ROI out of various tools that can each perfectly execute their core strengths.

Enabling machine manufacturers to switch from simple supplier to expert business partner

Corporate adaptability

Manufacturing plants and facilities don't simply purchase a machine, they purchase a tool that provides the output they want. To become fully mature in corporate adaptability means to adapt your business models to the continuous changes around us. Every single step we've discussed up to now unlocks opportunities for new business models. Enabling machine manufacturers to switch from simple supplier to expert business partner.

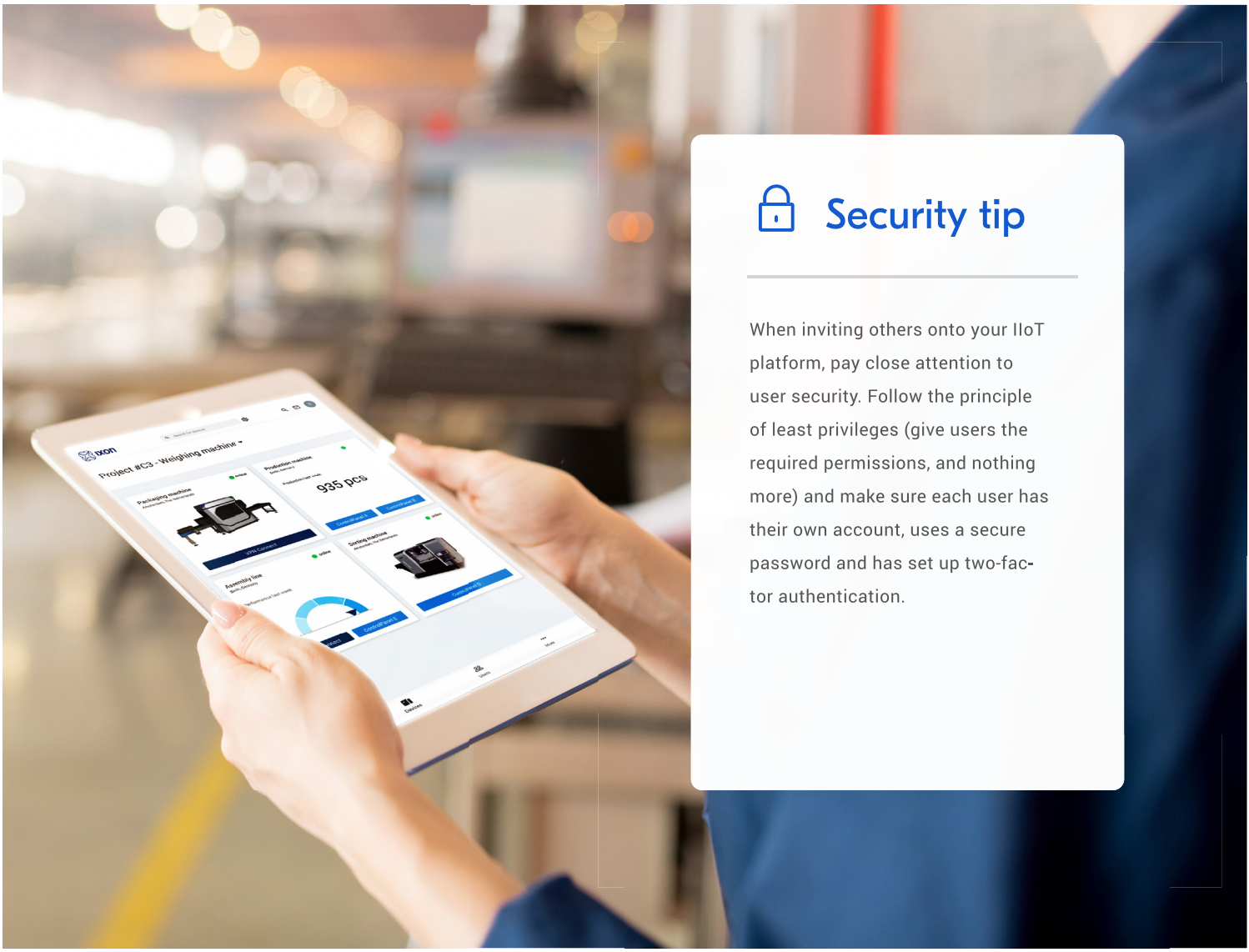
Analytics combined with expert knowledge enable machine builders to advise their customers on how to best utilize their machines, or to implement service contracts with preventive machine maintenance. Possibilities like these allow companies to explore new revenue streams like Service Level Agreements or pay-per-use leasing models. To successfully do so, machine manufacturers must fundamentally rethink their servicing and monetisation strategies.

Use case

HANSA Klima implements machine learning

HANSA Klima manufactures ventilation systems for various applications, such as swimming pools. Within, a wide variety of data is gathered, from the number of visitors, to water temperature, and solar heat coming in through the windows. "Through the mathematical evaluation of this data, the ventilation systems can energetically optimise the indoor climate according to the requirements in the forecast," explains Olaf Harms, IoT and BMS integration expert at HANSA Klima. "This helps the operator reduce his energy costs, while maintaining the same level of comfort."

Full story ›



Security tip

When inviting others onto your IIoT platform, pay close attention to user security. Follow the principle of least privileges (give users the required permissions, and nothing more) and make sure each user has their own account, uses a secure password and has set up two-factor authentication.

Requirements to fulfill the Adaptability maturity phase:

- ✓ Use an open IIoT platform to enable smart integrations
- ✓ Combine machine data, AI and external data sources
- ✓ Apply automated predictions and responses
- ✓ Rethink your business models to explore new revenue streams

About IXON

Getting from digitalisation to adaptability might be a long journey and a lot of hurdles to take. That's where IXON Cloud comes to play to start your IIoT journey today.

IXON's mission is to stimulate and aid in the IIoT transition among machine builders by providing a secure cloud environment with all the technology needed to make IIoT directly accessible to every machine builder worldwide.

Founded in 2014 to make cloud connection easier, secure and more accessible for machine builders and users, IXON is now one of the most valued and easy-to-use Remote Service & IIoT platforms specifically designed for machine builders and system integrators.

IXON offers an end-to-end industrial service solution with remote access, data logging, dashboards, alarming and much more. The IXON product portfolio consists of the IXON Cloud platform and the IXrouter, an industrial VPN router and edge gateway, which is specifically designed to connect machines securely and minimize the risk of data leaks. IXON delivers the technology, so machine manufacturers can do what they do best: collaborate with clients, provide service, and share insights.

Start your IIoT journey today and try the IXON Cloud product tour!

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