WHITE PAPER

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Lifecycle Data for Predictive Maintenance

MOVING TOWARDS INCREASED TRANSPARENCY WITH SENSORS AND CONNECTIVITY

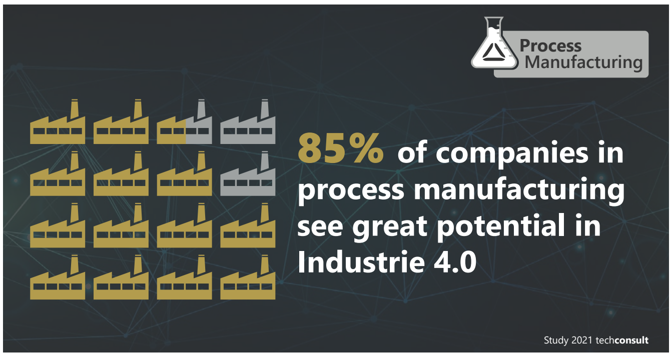
Improvements in a whole range of processes are the result when process technology is combined with the technology from the (Industrial) Internet of Things and connections are established between sensors and the central data platform of the ERP system. In the process industry, this applies primarily to preventive and predictive maintenance, proofs of quality in the manufacturing process, and heightened efficiency with track & trace.

INTRODUCTION

SMEs sometimes display a reluctance to take the plunge with IoT technology. "It's an interesting topic, but just too much for us," is frequently the response. However, experience from the manufacturing environment shows that the necessary technology is affordable and reliable, with implementation often possible within a very short time frame.

If we regard the digitalization of processes, products, and business models as a "triple jump," many small and mid-size businesses are still taking their first leap. In the process industry, product digitalization is often only a feasible option for the big players: Imposing standards requires market power. Digital services also prove tricky in many situations – sometimes because customers are not willing to invest any money to unlock the added value that these services bring. However, it is still possible for SMEs to realize significant optimizations in the area of process digitalization.

With good reason, smart or predictive maintenance were both identified as the first major application scenarios in manufacturing, within Industry 4.0. That is why an analysis of where costly downtimes most frequently occur is a worthwhile component of the strategic approach for these new options. Rethinking this represents a major challenge: Moving from previous alerts – a light indicates that everything is running OK – to other warning elements and concepts that can provide advance warning of faults that are going to occur.



But that is just one of many usage scenarios. However, there are areas of real concern that are deserving of close consideration in another context. In many companies, this could be the reduction of unproductive time spent searching for materials or parts, for example: Track & trace technology can contribute to significant savings here, accelerating logistics processes and increasing their efficiency. In parallel, they also support automatic adherence to legal regulations, such as those governing traceability in the pharma industry. In supply chains, information about the current status ensures that production planning is able to anticipate delays in advance. And mid-size companies can also derive compelling benefits from the use cases around IIoT and intelligent maintenance.

Definition: What the IIoT does

The Industrial Internet of Things (IIoT) describes a concept in which sensors provide data that is used as the basis for triggering automated process steps. The things in the manufacturing environment are connected, allowing systems and assets to communicate with one another. Raw data must also be prepared and analyzed. The objective is increased efficiency, flexibility and transparency, as well as cost reductions in manufacturing. IIoT approaches can improve your competitive position and contribute to growth.

USE CASE 1: SAVE DURING MANUAL INSPECTION

Significant savings potential can be realized when monitoring pipework. The integration of sensor technology that provides information for the ERP system and triggers processes there can prevent downtimes and allow problems to be predicted before they occur. Monitoring is particularly useful for typical trouble spots such as flange connections and seals, or transitions to containers.

It takes a lot of effort to inspect these locations manually. In some areas of the process industry, extensive statutory regulations are in place to prevent leaks – to stop toxic substances reaching the atmosphere or contaminating the ground, for example. Refineries must prove that flanges only generate a specific maximum leakage. This task is traditionally performed with tubes that show the quantity of a substance or liquid that has escaped. These are checked by on-site maintenance teams. It is possible to save on travel time for these teams by measuring the leaks with a suitable sensor.

Sensors for measuring wall thickness also provide important information about the state of a pipe or connector and show any deposits that may be reducing the width of flow. In conjunction with machine learning or the relevant AI models, it is possible to predict reliably when a problem or malfunction will occur if the deposits continue to increase. In automated processes, a spare parts order and a maintenance assignment can be triggered directly in the ERP system.

USE CASE 2: INTELLIGENT MAINTENANCE OF PLANTS AND ASSETS

The combination of sensor technology and AI can also be applied to other areas: Vibration analyses can help to detect anomalies in advance, such as when a compressor is not running smoothly, for example. AI-based audio analysis within facilities can help to recognize abnormal sounds. The topics of failure safety and reliable information about the probability of failure also play an important role in batch manufacturing. Smart or predictive maintenance help to find better solutions for particularly problematic points in the manufacturing process. A solution should always include the specific expertise of those employees who are most familiar with the production facilities: Experimenting with AI and hoping for the best is generally not a successful approach. Domain experts are required just as much as data specialists.

With regard to SMEs, there is an urgent need for viable approaches that can be applied to real life and do not require huge projects or major investment. One method that has proved to be particularly practicable is the adoption of preventive monitoring, which goes one step further than traditional condition monitoring. The focus is on the recognition of anomalies. The analysis of sensor data takes place based on artificial intelligence. The algorithm can be trained in a relatively short period of time, during which the machine, plant, or equipment remains in operation without errors.

As soon as a deviation from the norm is detected, a service ticket is automatically created to check this irregularity and prevent more serious problems from occurring. Companies can initially cope well without the data history that is actually crucial for predictive maintenance.

Nonetheless, it is vital to gradually build up a good data basis. This includes data that shows how everything is running OK, but especially the data that is recorded during downtimes and problems. The key terms here are data classification/labeling. This is the only way to improve how AI algorithms learn from the data. The maintenance teams also need to enter downtimes and measures taken in a standardized fashion, to allow the inclusion of this knowledge as well.

Using a distillation plant as an example:

- Wichtige Anlagenteile der Destillatfabrik sind mit IoT-Sensoren ausgestattet
- Important components within the distillation plant are equipped with IoT sensors
- The sensors continuously monitor the state of parts, such as wall thickness or temperature
- An app visualizes sensor data and reports critical events to the responsible employee
- Lifecycle data for equipment is stored in the cloud and is then available as input for predictive maintenance
- The data forms the basis for simulations that are used for virtual testing of other configurations

An integrative data platform is the key to optimal maintenance

Experts are of the opinion that a reactive approach to maintenance still predominates, especially in the process industry. The connection between production and maintenance data is key when approaching the topics of preventive and predictive maintenance – indeed, achieving your objectives will prove difficult without this. The ERP system is the ideal data platform. Including energy data allows conclusions to be drawn by comparing typical energy consumption with the current figures. Deviations could indicate potential problems, which may also have an effect on product quality – if a pump is operating more sluggishly because ingredients in processing are more viscous than usual, for example.

Specialists calculate that connecting data previously stored in silos can improve the OEE (overall equipment efficiency) key figure by up to ten percent. In this context, attention should still be paid to the whole topic of quality by design, whereby quality checks are an integral part of the process instead of being applied after manufacturing is complete. Maintenance and quality checks often make use of the same parameters and sensor values.

In some areas of the process industry, such as the pharma industry, regulations demand meticulous documentation of manufacturing processes. Asset integrity plays a key role here. It may well be worth pursuing a path towards the digital twin for production facilities, as this enables reliable, automated notification – by replicating a digital copy of the real production situation, including the proper organization of all necessary maintenance actions and checks.

Increasing relevance of data analysis and forecasting

In their reference work "Enabling Industry 4.0 – Opportunities and Benefits for the Process Industry," authors Thorsten Pötter, Jens Folmer, and Birgit Vogel-Heuser address the recent trend of monitoring the quality of production processes: "In practice, this means increased connectivity of online analysis methods – for the process industry as well – to control fluctuations within the entire production process. The level of automation will continue to rise; simulation and forecast processes will become increasingly important and feasible. There will be an even more comprehensive exchange of information, which must continue to take place at the required speed. The traditional automation pyramid will no longer retain its form but the functional scope will remain, and may be extended, while data access will become more flexible."

Use Industry 4.0 where it fits in with batch manufacturing

In batch manufacturing, it is often not possible to implement the concept of Industry 4.0 in such a way that a product provides all the critical information during its manufacture. Nonetheless, vertical and horizontal connectivity with extensive provision of information on central hubs plays a decisive role here, generating more flexibility in production. Standards such as OPC UA help various facilities and IT systems to communicate with one another. Corresponding concepts are particularly useful for the discrete manufacturing areas that are also to be found in process manufacturing, including packaging.

Unlike the previous hierarchy, which occurs due to the SPS connection, cyber-physical systems (CPS) distribute the data to all systems and applications that they require. The savings potential is quite high as previous, rigid systems were very sensitive to change. For example, specific SPS programming must be performed for each new measurement device and the SCADA system must also be reconfigured. CPS reduces the dependency on lower-level layers.

USE CASE 3: TRACK & TRACE FOR MORE TRANSPARENCY

Track & trace represents another area in which the use of sensor technology pays off. For example, it is possible to monitor the movements of vehicles on company premises, which can also simplify the consolidation of materials for individual batches. Bluetooth sensors can also be used to protect critical areas, by automatically logging the time at which personnel enter and leave these areas.

It is also possible to implement application scenarios in which material and products may only be exposed to a set range of temperatures, humidity levels, or brightness during storage and transport. For example, problems can arise during further processing of coatings if a minimum temperature is exceeded. In conjunction with the ERP system, temperature sensors can indicate these problems, allowing potentially defective batches to be weeded out, or ideally providing the opportunity to initiate countermeasures.

In many instances, the logistics area does not have clear visibility on the location of barrels, pallets, containers, or load carriers, or whether they are set to arrive on time. This often leads to inadequate planning for loading bays and gates, and to stockpiling inventory as a precaution. Sensor technology allows you to trace material, almost in real time, and lays the foundation for a frictionless flow of materials and avoidance of manual errors.

On the one hand, it takes less time to find materials and verify the data in the ERP system. On the other hand, the flow of materials can be optimized by geofencing, for which rules are defined in the ERP system.

Track & trace boasts significant savings potential

Companies generally benefit greatly from practical projects, in which Bosch sensor technology expertise for track & trace is linked to the Microsoft Azure platform. That is the conclusion reached by Bosch, having calculated that search, inventory, posting, and scanning efforts can be **reduced by up to three quarters** with track & trace. Simultaneously, it is also possible to utilize 10 to 25 percent more capacity for logistical assets such as trailers. The availability of circulating load carriers can also be increased by a quarter, while time savings of around 50 percent are possible when collecting status information and coordinating material flow processes.

Tracing in real time

Considerable savings potential can also be realized from sensor data about where information for process-related operating resources is stored and analyzed. Many areas of industry require intensive consumption of water and energy. Therefore, it can be worthwhile to track consumption components such as power or water. This is not just to adhere to regulatory requirements, but also to meet those commitments to increased sustainability that are becoming ever more crucial for many customers.

There are now considerably more legal requirements regarding sustainability in the pharma industry, but similar efforts can also be useful in the areas of chemicals and cosmetics. From packaging onwards, products must then be registered with a unique ID, such as a serial number, whenever they reach the next station along the supply chain. All participants in the chain require access to the data, from retail to logistics. This is the only way to guarantee real-time tracking and subsequent tracing.

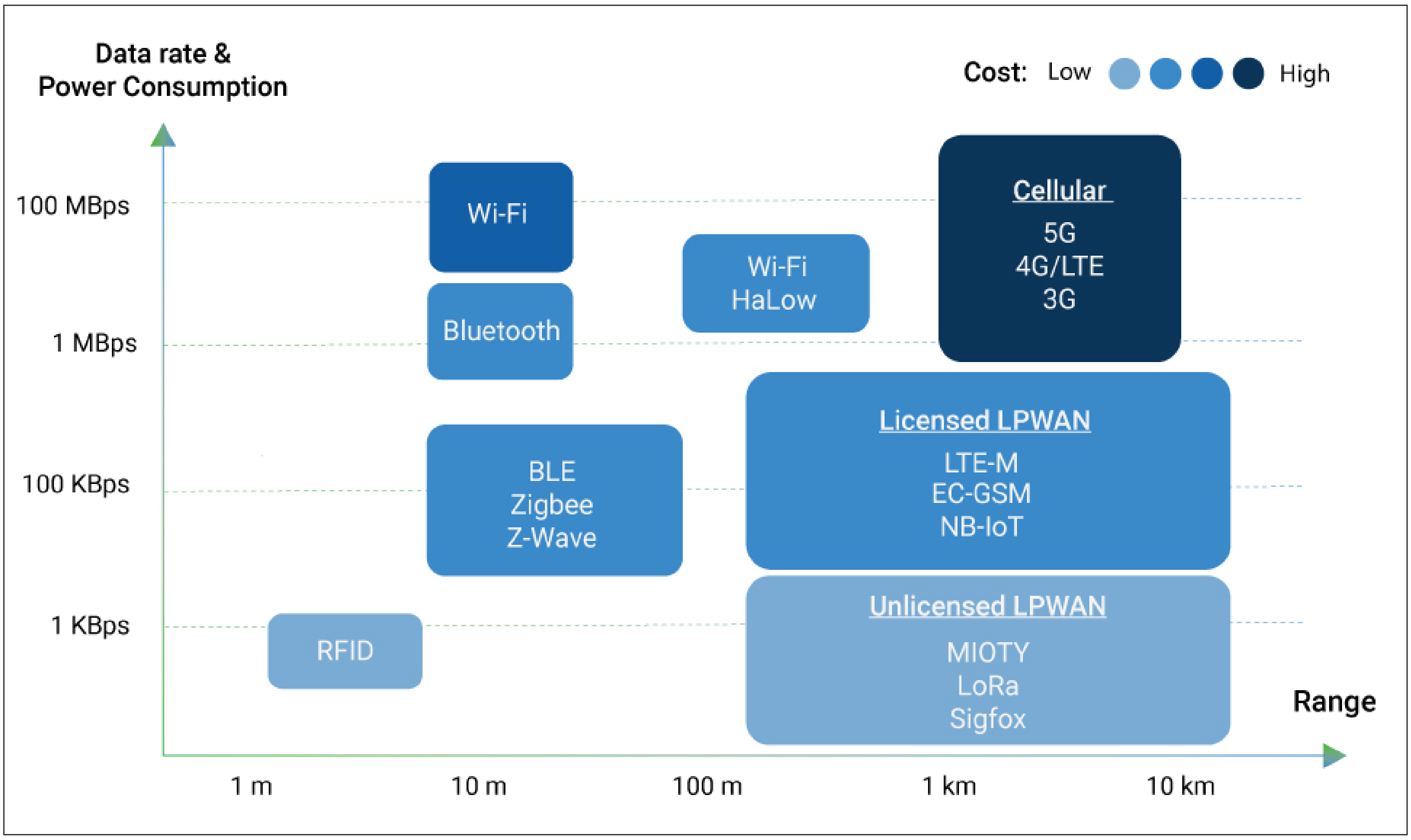
Connectivity can be achieved

In the manufacturing environment, many companies use wireless networks to connect sensors and link facilities. The advent of 5G puts improved scenarios related to security-critical, real-time automation and simulation within reach for these companies. Germany still has ground to make up in the expansion of the broadband network. Even in areas of production with poor network coverage, it is possible to implement LPWAN (Low Power Wide Area Network) technology or LoRa radio transmission. LPWANs are characterized by the transmission of small quantities of data within a radius of up to 20 kilometers, and economical sensor batteries that can last for as long as ten years.

Take care when choosing sensors

In areas of particular concern, it is often worthwhile to be able to use technology to predict levels of wear and plan required service assignments before the malfunction occurs. However, it is not always a simple task to find the right sensors for a particular context.

For example, you can select very simple sensors that are affixed to a pipe – to catch anomalies in defined tolerance ranges – or complex measurement systems, and everything in between. There are plenty of products to choose from, but not all of these are suitable for industrial use: And even when you find the functionality you require, there is no guarantee that a sensor will also work reliably with explosive gases or in robust environments with very high or very low temperatures. This is where experienced partners can support you to choose the sensor technology you need.



Depending on the usage scenario, various transmission technologies may be suitable for the individual use cases, from Wi-Fi and Bluetooth or cellular telephony to RFID or LPWAN.

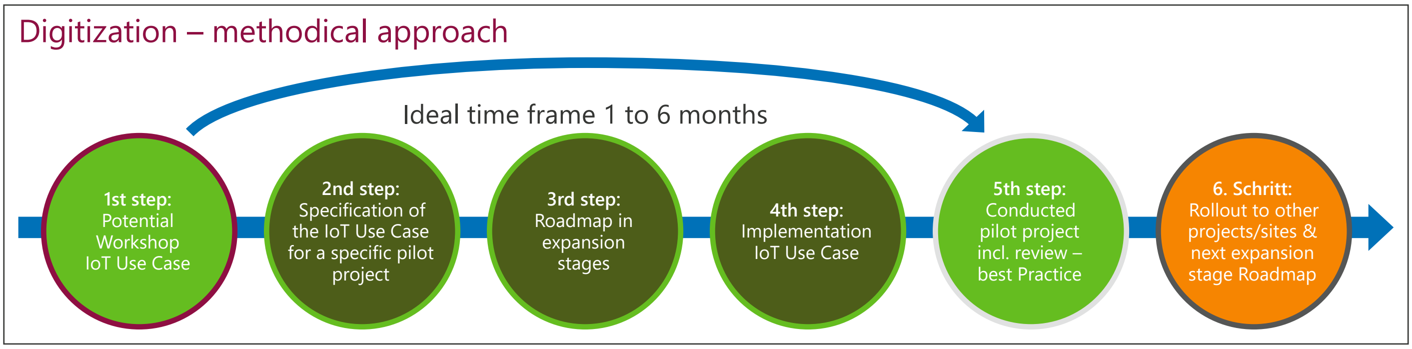
IIoT only succeeds with an intelligent data hub

However, there really is little point in purchasing various individual solutions that each require proprietary software from the manufacturer to allow the sensor data to be exported. The focus here needs to be on platform thinking: The answer is a neutral platform such as Microsoft Azure IoT Hub, which gathers, processes, and consolidates the raw data using manufacturer-independent interfaces. To allow the data to reach the necessary point in the process, this must also establish integration with other systems, such as the ERP system. This also applies to information that is to trigger an alert, spare parts procurement, or a maintenance assignment.

Step-by-step approach instead of a "monster project"

But how does an IIoT solution actually get up and running? As in other areas, the proven method is to start small – within the framework of a strategy that relies on flexible extension with new functions and services. Initial experiences are then incorporated into the next steps. Depending on the use case and the potential benefits, extensions are then possible based on the same platform.

The challenges include integrating the company's mature systems into modern technology such as the public cloud and IIoT by guaranteeing a high level of data transmissibility between components – between smart assets, sensors, and the ERP system. There is often a lack of internal know-how about how to orchestrate a system landscape of this type. This is the situation that lends itself to cooperation with a service provider that can provide the required combination of ERP experience, cloud know-how, and knowledge about processes and challenges in process manufacturing. This is the way to address problems that previously would have taken a considerable amount of effort to solve.



A sensibly constructed toolkit and the right platform enable you to implement IIoT solutions quickly and consistently.

CONCLUSION

Process manufacturers can use new technological concepts based on sensors and other smart assets to accelerate all processes, not just their own, and to make better decisions based on real-time information. Topics related to transport, logistics, and traceability all contribute to increased security and customer loyalty. A central IoT data platform is essential to implement the various solutions effectively in practice.

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Torsten Harnack is the industry manager responsible for process manufacturing and the further development of our solutions.

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