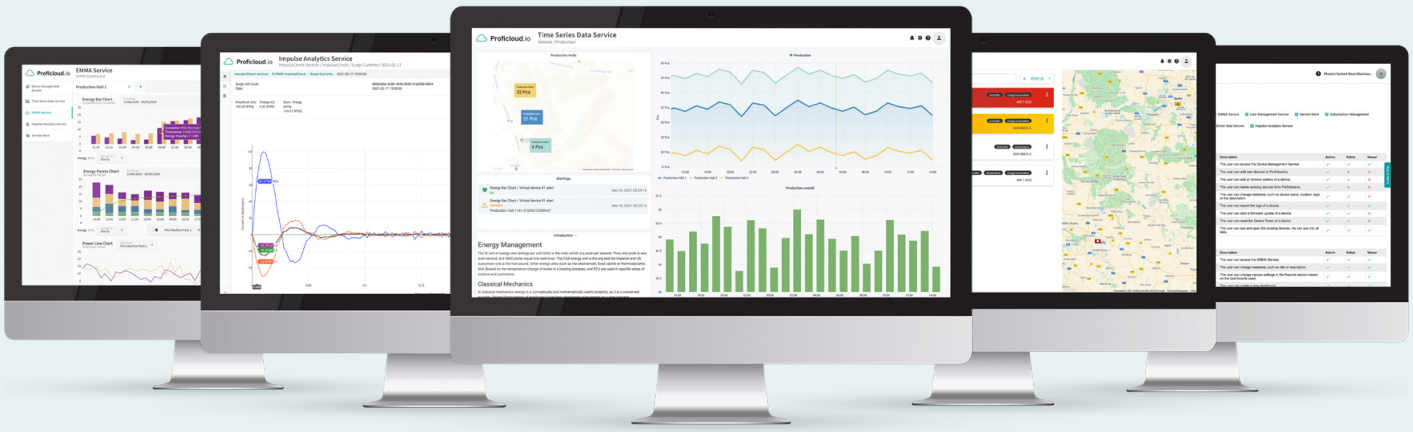
Introductory Guide

From sensor to cloud

Connectivity and data analysis for small and medium-sized enterprises (SMEs)



PHOENIX CONTACT
Smart Business GmbH

Introductory Guide

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Connectivity and data analysis for small and medium-sized enterprises (SMEs)

Our customers can quickly and easily benefit from their machine data. This guide tells you what you need to know and how to proceed to communicate effectively. It bridges the gap between proven Phoenix Contact hardware, the Proficloud.io IIoT platform and our Smart Services. Furthermore, this guide outlines the basics worth knowing about machine data, sensors, data transmission and evaluations. Above all, it should become clear how easy it is to implement a pilot project with Proficloud.io and the Smart Services, from which many companies can derive visible added value, including just a few preliminary considerations. A decisive plus point here: Users can start their first experiments with Proficloud.io without excessive IT knowledge.

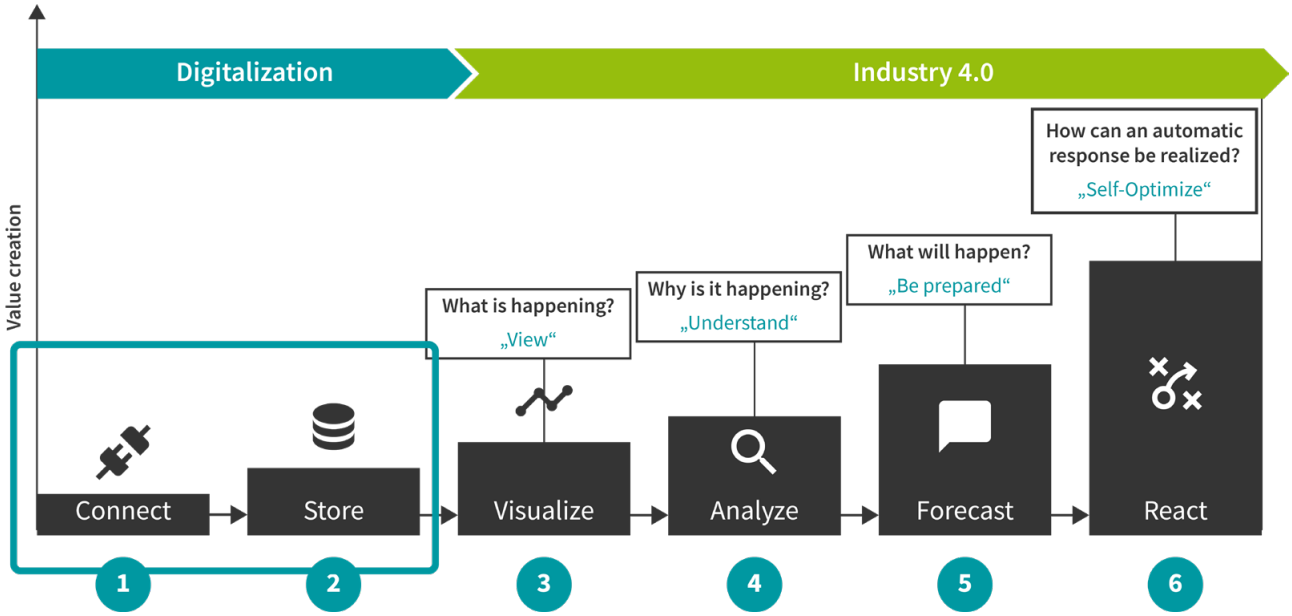
Contents

1 Introduction

In modern machines and plants, a lot of data is already available in the PLC. Older machines can be retrofitted with sensors and additional hardware for data acquisition with little effort. Most companies know that machine data is valuable. Machine data collection (MDC) can significantly increase availability and achieve other valuable effects. However, when it comes to systematic data collection, storage, evaluation and visualization, many small and medium-sized companies consider the investment in technology and know-how to be (too) high.

This is where our IIoT platform Proficloud.io comes into play with its smart services (apps) and makes the data treasures more useful and easier to access than ever.

In this guide, we focus on connecting machines and storing data in the Proficloud.io platform. In the last chapter we will provide a brief overview of the smart services for visualizing and analyzing data, as well as their added value for companies.



Value creation by degree of digitization, divided into 6 levels | Source: FIR e. V. (RWTH Aachen)

Anyone who wants to derive added value from digitization and “Industry 4.0” must first deal with the basics at Level 1 and 2: Networking, collecting and storing data. This guide focuses on these steps. Let‘s start with data types.

2 What is data

- and why should every company care about its machine data?

Colloquially, data can mean all conceivable facts, points in time and calendrical data. In addition, the term includes numerical values obtained by observation or measurement, often combined with physical units. For our context, all machine-readable information that can be stored, copied and processed is considered. The three most important forms of data for us in the production environment are:

Process data:
These are the values that a machine needs for control and that it in turn obtains during operation - often by means of sensors. Typical variables are throughput quantity, pieces produced, pressure, temperature and energy consumption. These data are used to monitor, control and optimize work processes. A machine tool measures the number of processed workpieces per hour, the pressure in gas containers must be constantly measured, and a specific temperature must be maintained in ovens.

Time series data:
As soon as similar process data are structured according to time, they are referred to as time series data. This is well known from everyday life - for example, the course of a share price over several months. For companies in industry or infrastructure, it is interesting to know exactly when consumption peaks occurred or whether there were anomalies or deviations of any kind in the process data. Then, for example, the company can determine whether the reject rate has increased at certain production times - and eliminate the causes.

Metadata:
They describe the data properties. An example: Digital cameras store the metadata of a photo at the beginning of an image file in the Exif format: date/time taken, focal length, exposure time, location coordinates via GPS. In industry, much process data is automatically enriched with metadata, including data format, location and time of capture, and data from the application software. Metadata of this type is rarely used, but can potentially be used in monitoring or evaluation and can help with filtering and searching for data records.

Data treasure in the enterprise:
From Blind Flight to Smart Data

At companies a lot of data accumulates automatically, such as product information, sales figures, power consumption and the status of machines. However, how companies handle this data varies greatly. In the simplest variant, it is to expect that data is collected and stored manually. An example would be an employee who checks the pressure display of a gas tank at regular intervals and documents the values in a list (which disappears in a file folder unless something seems conspicuous). Systematic and efficient analyses can hardly be implemented this way, even if the list is an Excel list.

In contrast, digital sensors enable continuous monitoring of important data - production quantities, capacity utilization, runtime and availability of a machine and individual functions, energy consumption and machine health. If critical limit values are exceeded, an automatic alarm can be triggered. The potential for improved machine availability and other added value is significant.

In practice, two scenarios are typical in the industry:

1 The digital data capability of machines and plants is unused. Data remains „in the silo“ on site, is not transmitted and evaluated. If the production management conducts data evaluations, then only selectively and locally. An overall view of the production environment or of several locations is missing.

2 Data is routinely stored in an automated manner with lots of volume and from several machines in an unsystematic manner. However, no benefit can be derived from the treasure trove of data because the data resides in separate systems („island solutions“ or “silos”) and the technical connection to a central storage location seems too costly. And even if this raw data is available in one place, a company may find the analysis and interpretation too costly.

Small and smart choice: Smart Data

It always becomes interesting when machine data can be used specifically for corporate management - for example, for asset (device) management. This is always possible when relevant information can be extracted from mountains of data. This requires smart data - meaningful data sets that are extracted from larger raw data volumes. This can happen manually, with modern apps that make meaningful suggestions, or in the „highest developed stage“ with algorithms that automatically work their way through the data. They collect, filter, organize, analyze data and visualize it for the user. The more specifically the relevant data sources have been selected, the clearer the result, and the easier it is to discover optimization potential.

Let‘s take the gas tank as an example again, this time equipped with a digital pressure gauge that constantly transmits its values to a central cloud solution. This enables ad hoc availability of the information on all devices, at any location with working internet connection. This allows management to make decisions at any time. Not just when the production manager reads the reports from the night shift in the morning, for example. Meanwhile, time series analyses are effective in the long term, as they show that the frequency of pressure drops is increasing after a few months, for example. “Showing” here means: The responsible worker recognizes the problem in time, because it is graphically prepared on his tablet. One consequence could be to increase the maintenance cycles

in order to prevent the total failure of the important plant in good time.

This kind of added value can be achieved for machines and plants of all kinds. Properly implemented, the use of machine data becomes a key factor in production. Performance and quality within production increase, as does the availability of the machines. This significantly increases the competitiveness of a company. This can be measured, for example, by the overall equipment effectiveness (OEE).

Our solution approach here is the IIoT platform Proficloud.io. Sensor data lands directly in the cloud, evaluations and visualizations are carried out via our Smart Services, which already have many useful presettings. This approach is a tangible solution, especially for small and medium-sized companies, because the investment costs are comparatively low. Their own special know-how or a data scientist are not required, nor are they negatively affected. The solution is also scalable, so it can be quickly and easily expanded (or scaled down again) as needed.

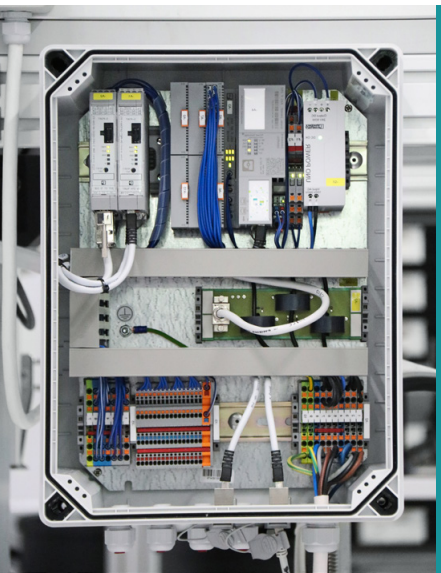
3 Sensors

You can only manage what you measure first

Collecting data: This first requires suitable sensors in the plant or in the field. They form the basis for targeted data acquisition. By sensor, we mean any type of data source on the shop floor. Ultimately, any device that measures a relevant variable can become a useful sensor on the shop floor, be it distance sensors, temperature measuring devices, light barriers, level indicators or entire machines.

We place a special focus on sustainable manufacturing companies that want to improve the recording and saving of energy. With our multifunctional EMpro energy meters, power measurement terminals and other products, energy data can be recorded and forwarded quickly and in a targeted manner. You benefit, among other things, from fast commissioning and monitoring options using smart web service and display functions.

If no sensors exist or the connection is missing, the existing systems need to be retrofitted. However, this means extensive intervention and a change to a machine. In addition to the high effort, this can lead to a production standstill and, in some cases, to the loss of certifications and approvals. In this case, Phoenix Contact‘s „Data Collection Box“ solution is ideal for integration. The compact housing accommodates a combination of PLCnext Control, Ethernet I/O controller, which connects digital and analog signals from the sensor and actuator level with the IP network (TCP/IP, BACnet/IP and Modbus TCP), and measurement modules. The box allows quick and easy installation on existing machines and systems.



Important for the industry

A Data Collection Box can be installed with so little intervention on the running system that no recertification of a machine or similar is required.

4 Data transmission

Through cable and air - and in one language

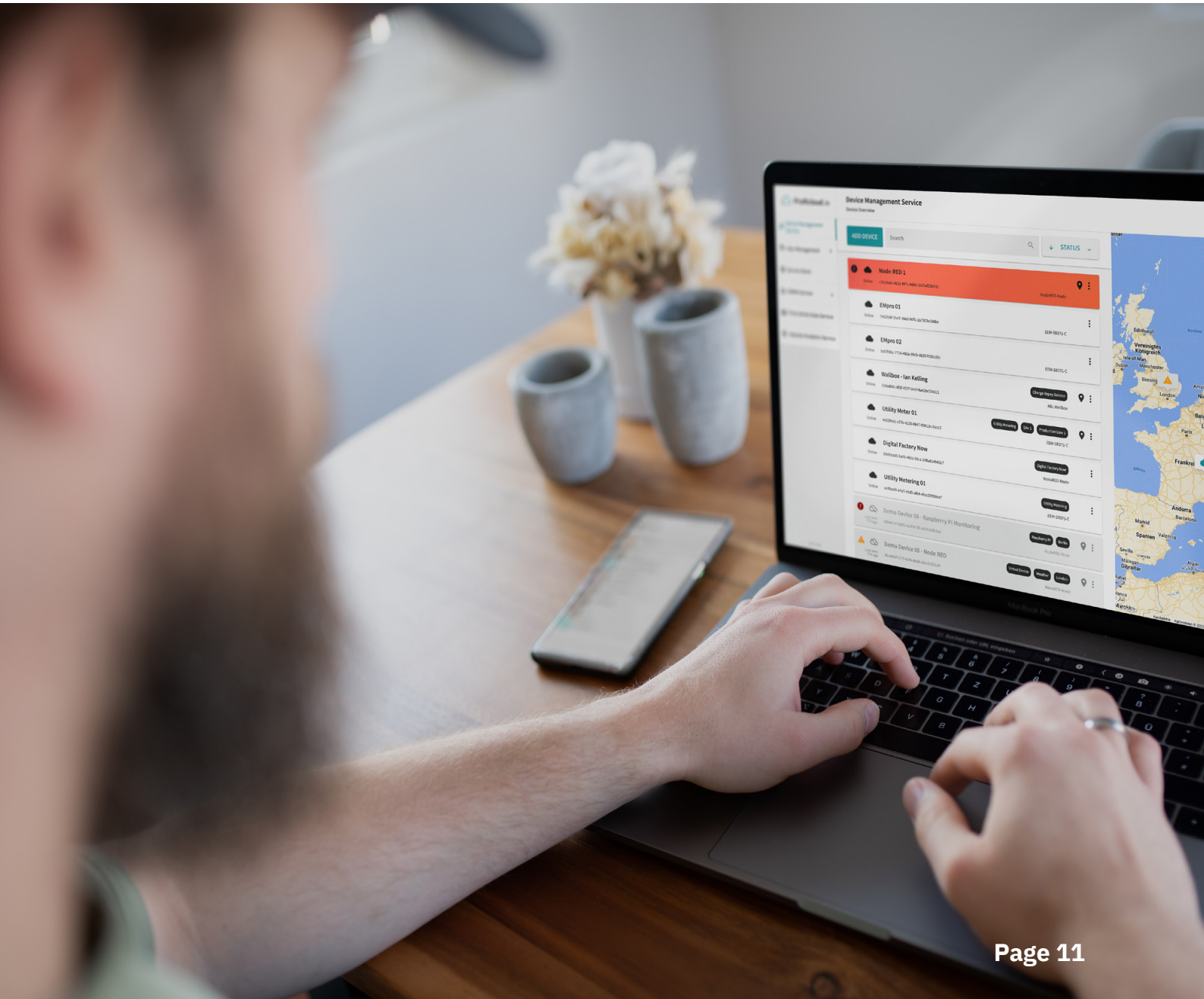
Data-driven optimization of processes requires direct information from the processes of sensors and actuators. Before the data can be processed on the Proficloud.io IIoT platform and by the smart services, it first has to get there. To do this, the devices are integrated into the company‘s network - either wired via Ethernet or wirelessly. A common problem here is that the installation of many Ethernet connections is costly, making an economical connection to the network impossible. The solution to this problem is called **Single Pair Ethernet (SPE)**. Single Pair Ethernet connections consist of only one pair of wires. They allow continuous and cost-effective Ethernet communication all the way to the sensor. Simple sensors, actuators and end devices can thus be integrated economically.

However, wired connections alone are not sufficient for a self-optimizing, highly flexible and sometimes (partially) autonomous production. Even a simple example shows that mobile technologies such as RFID chips cannot be detected; a wireless network with sufficient bandwidth is needed. This network can be realized today with 5G. **5G technology** offers significantly higher transmission rates than 4G or wifi. It also has real-time capability - which becomes important for applications such as automatic stops to prevent hazards. The key advantage, however, is that private (= secured) networks become possible. Special frequency bands are reserved for companies for this purpose.

Once all devices and the associated sensors are integrated, one problem remains: the different languages, because sensor communication is based on various protocols. In order to be able to use diverse sensors nevertheless, gateways are used. These act as translators and enable communication via a common language. In the industrial context, OPC UA is often used as the common language. This stands for **Open Platform Communication Unified Architecture** - a common, platform-independent communication standard for machines. The technical structure is complex, but the objective is clear: communication from the machine to the cloud is standardized, and cross-system communication of all devices in networked production

is ensured.

The devices are now connected via SPE, WLAN or 5G. Unfortunately, they are „talking“ to each other: some applications are updating, while others are transmitting data to the cloud. At the same time, the process control system orders the assembly line to reduce its speed, because the scrap rate determined via a light barrier is getting too high. Which facilitator is orchestrating now? The answer: **Time Sensitive Networks (TSN)** prioritize data streams and generally ensure order in communication. Individual requirements are taken into account - for example, if low latency is necessary for safety reasons in certain processes.



5 11 facts

Data security and privacy with Proficloud.io

Wherever there is a lot of communication, there is also the possibility of spying or manipulation, and this also applies to the transmission of machine data to the local network and to cloud applications. A high level of data security should be guaranteed throughout the entire value chain. There are international standards for this, to which device manufacturers and service providers are guided. For industrial communication networks, for example, the IEC 62443 standard defines standards for the entire communication process. Compliance with these standards prevents data from being intercepted at interfaces - especially in the case of media discontinuities.

While data security means protection against loss and unauthorized access, data protection is concerned with the misuse of personal data.

As a platform for the Industrial Internet of Things, Proficloud.io needs and delivers very high standards for both areas. This means that personal data, as well as process and product data, is secure on the platform and during transmission. What does „certified“ mean in this context and what does Phoenix Contact Smart Business do for data security? Here are 11 facts:

1 **Encryption:** All connections between users and Proficloud.io are encrypted with TLS 1.3, connections between devices and Proficloud.io are encrypted with TLS 1.2.

2 **Vulnerability scanning:** We use a vulnerability scanner for web apps (automated security and asset monitoring) to monitor the web apps for potential takeovers and fix vulnerabilities as soon as they are known. We use products to automatically prove our code quality and security.

3 **Hardening Techniques:** We apply various hardening techniques to our service containers - e.g. use of service packs, automatic dependency checks, patches & patch management, etc.

4 **Data protection:** Proficloud.io is fully GDPR compliant (“DSGVO” in Germany) and therefore meets the highest data protection standards.

5 **Operating system:** All our virtual servers are based on Linux operating system, which increases the security of our cloud system. Linux, as the largest open-source software project in the world, is known for closing security holes quickly because many independent developers are working on it.

6 **Spectre/Meltdown and other CPU security vulnerabilities:** Infrastructure is continuously updated with new protections and no customer action is required at the infrastructure level.

7 **Permission/User Management:** We provide a sophisticated permission management system that allows organizations to control exactly what users are allowed to access.

8 **Password Policy:** Highly secure passwords are enforced by the platform. In general, the password must be at least 10 characters long, contain upper and lower case letters, numbers and special characters.

9 **Public Key Infrastructure:** We use EJBCA as Public Key Infrastructure (PKI) for all users on Proficloud.io, so we can revoke potentially compromised certificates at any time.

10 **Sichere bidirektionale Gerätekommunikation:** Secure bidirectional device communication: CA-signed remote commands are used in relation to the connected devices. All communication is encrypted using TLS 1.3 and client certificate authentication.

11 **Data centers:** Phoenix Contact Smart Business uses AWS data centers located in Germany to operate Proficloud.io, guaranteeing an industry-leading level of security for customers.

6 Turning data into good decisions

The Smart Services from Proficloud.io

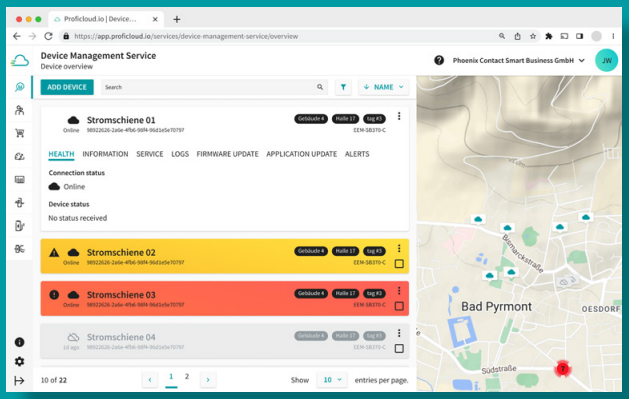
Let‘s move on to the actual added value once the technical requirements have been met and the desired machine data is flowing to Proficloud.io. Companies can then add a range of smart services as required, which filter out relevant data from the data streams and prepare it visually.

For example, as soon as a machine is connected to Proficloud.io, the production manager can be continuously informed, he can set alerts - and he sees, for example, the high-frequency recorded energy profiles. From this, he can derive conclusions about the condition of the machines. Malfunctions and problems of the control system can be viewed in the „Device Management Service“ - on mobile devices or even on the desktop. Anyone who wants to analyze process data and store, compare and evaluate it over a longer period can do so using the Time Series Data Service. Measures can then be derived and justified from clear data series in order to increase efficiency and reduce downtimes.

Our top five smart services:

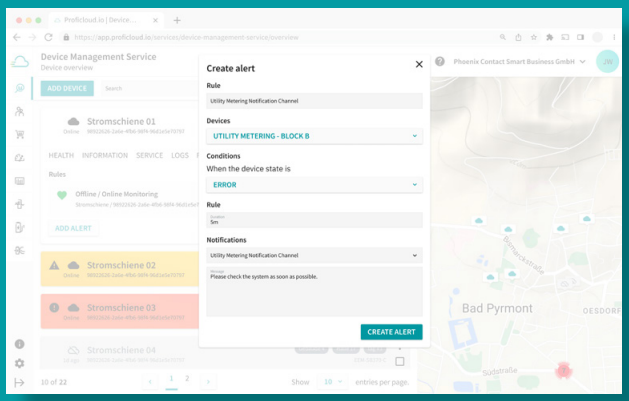
Device Management Service:

This smart service allows users to add and manage their devices, machines and equipment. It offers standardized device information in real time: Users can see the status at any time on a clear interface. Firmware updates for Phoenix hardware can be imported in a centrally controlled manner.



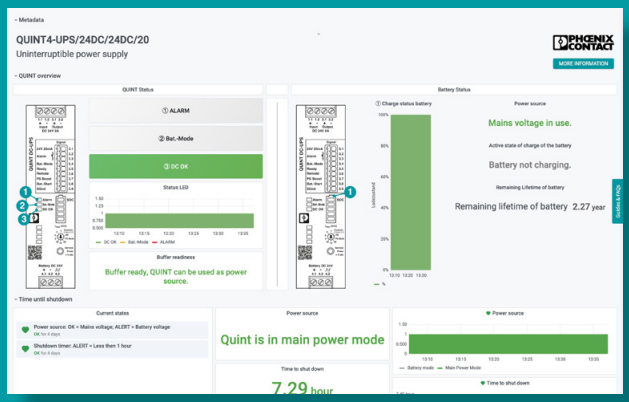
DMS Basic Add-on:

The first add-on of the Device Management Service offers additional functions for the control of distributed systems. Particularly useful: automatic firmware updates; notification system for notifications of changes in the health status of a device; remote application update (currently only for PLCnext hardware); creation of device groups.



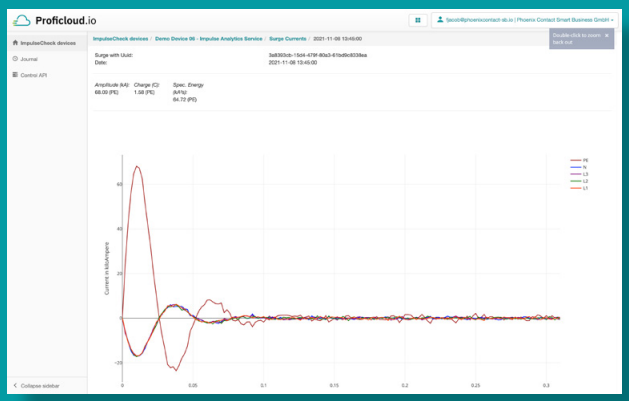
Time Series Data Service:

This allows access, monitoring, and recording of all types of process data. This includes, for example, the flow rates, temperatures, and energy profiles of machines, which can be used for long-term data-driven decisions. An alert function informs users as quickly as possible if defined threshold values are exceeded anywhere.



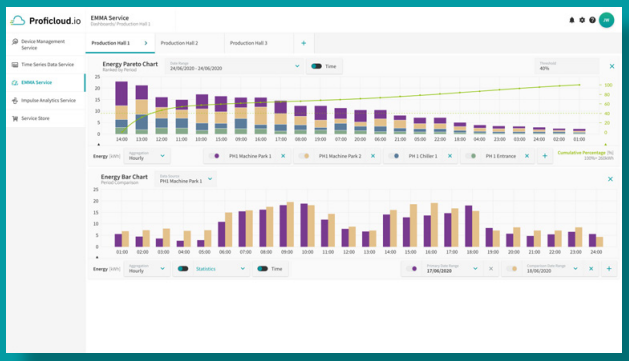
Impulse Analytics Service:

In combination with the IoT-enabled devices for ImpulseCheck, this service is the first intelligent assistance system for surge protection. The state of health of all protection devices integrated in the cloud is visible, so that the service life can be predicted much better.



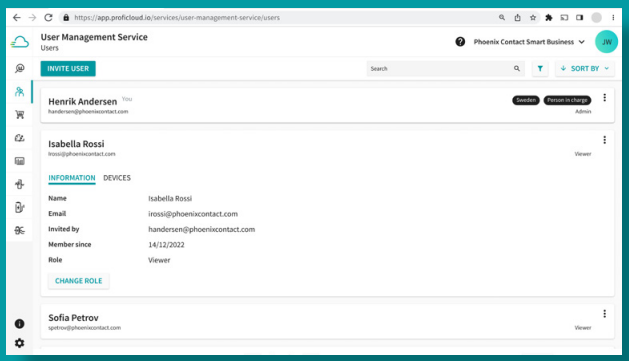
EMMA Service:

The abbreviation stands for Energy Monitoring, Management, Analytics. This smart service and the IoT-capable EMpro energy meters enable modern energy management that, among other things, identifies and exploits savings potential. Individually adjustable alerts inform immediately when threshold values are exceeded.



User Management Service:

With this core service, the company organizes its users in Proficloud.io. They can be assigned individual devices, roles (admin, editor, viewer) and permissions, giving users access to the dashboards and data relevant to them.



7 Plan a data project

Like any IT project, a data project should start with a concrete objective. After all, the effort must be matched by a concrete benefit. This is followed by a list of the actual and target status and the recording of the technical requirements. Based on this, the internal IT can start together with us as a data partner.

Step 1:
Determine goals. Many problem areas will be known to production management and employees. They can therefore be identified quickly, for example: no overview of the status of the machinery and many walking routes, low machine availability, high consumption of electricity, heat or raw materials, quality problems with the end products (high reject rates). Some of these factors will also emerge as critical KPIs at management level - accordingly, the relevance of an early solution increases in the company. More transparency, increased machine availability, optimized delivery reliability, possibly with a specific target (for example „10 percent electricity savings in cooling operations“). These are all goals based on systematic data collection and evaluation. If there is little or no experience with data evaluation, it is advisable to start with easily achievable/realistic targets: Often, simple monitoring already brings great added value.

Step 2:
Analysis of the current state of data evaluation. This is where we trace how data has been recorded and evaluated up until now: Does the production management mainly rely on the individual know-how of the employees? Which sensors have been used to date to measure physical variables? Is there already digital data acquisition, but no continuous evaluation? Is there a lack of overview of the many data sources? Is the analysis effort considered too high and therefore not pursued? Can something be built upon or does a new solution have to be implemented? Keywords here are „brownfield“ - improvement of an existing solution - and „greenfield“ - realization of a completely new approach.

Step 3:
Definition of the target state. Here, the company describes the desired outcome of the introduction of a data solution: Which data should be available and which employees need access? Which insights should

be gained from the data in real time and which continuously in order to achieve the defined goals?

Step 4:
Gather requirements. Step 3 results in the qualitative and quantitative requirements for the type of data and data collection. Example: If the goal is timely machine maintenance and spare parts procurement, then the maintenance team must be able to quickly detect and act on anomalies in energy profiles. This helps achieve the goal of increased machine availability. From now on, it‘s all about the specific technical requirements: In the example scenario, energy meters for high-frequency data are needed. In a pilot project, selected machines would then be connected and their data would be evaluated. EMpro energy measuring devices are ideal for this, as they play their data directly into the Proficloud.io platform. How wireless networking is implemented depends on the conditions on site; possible options include transmission via narrowband IoT, Bluetooth Low Energy and Wi-Fi.

In addition, the company should check the extent to which new software for recording, storing and analyzing data works with existing IT systems, i.e. how interoperable it is and what interfaces it offers. Small and medium-sized companies in particular should pay attention to the flexibility and scalability of a new IT solution: With what effort can it be adapted? Is it modular and thus quickly expandable? This is where our Smart Services – powered by Proficloud.io are the optimal choice.

Another target group
Data evaluation solutions are not only of interest to manufacturing companies, but also to machine and plant manufacturers who want to add value to their products. They don‘t have to network legacy systems, but instead achieve new added value for their users in their products with sensors and data evaluation options. The use of a data solution in this case therefore comes from a greenfield perspective.

8 Conclusion

Why start such a project together with Phoenix Contact? A key customer benefit is that Phoenix Contact has been combining its well-known and proven hardware portfolio with a secure and powerful IIoT platform for some time and with growing demand. We therefore supply hardware and software from a single source, coordinated with each other and designed to meet the typical needs of our customers - Made in Germany. In doing so, we focus on simplicity in installation, scaling and application. And we focus on the really relevant data, so that obscure mountains of data become smart data for smart decisions.

Smart Services

Powered by Proficloud.io

Take back control of your maintenance and operations

Smart Services are easy-to-run, standardized and scalable cloud services for industrial environments that empower small and mid-sized companies to manage their operations and maintenance processes as efficient as possible.

Reduce manual and redundant work steps with remote monitoring across devices and locations. Increase the availability of your systems thanks to early error detection and automatic alerts. Make better, data-based decisions and gain full transparency on the status of your systems – at any time, from any location.

Proficloud.io

Designed by Phoenix Contact Smart Business

Your ticket to industrial IoT

Proficloud.io is a Plug and Play IIoT platform that empowers small and mid-sized companies having no own or only limited IT resources to easily connect their devices to a cloud infrastructure. The goal? Use the full scope of advantages of Smart Services to unleash the full potential of your business!

Thanks to intuitive web interfaces and dashboards, Proficloud.io offers maximum simplicity when using the cloud platform. Registration only takes a few minutes and no previous (IT) knowledge is required to use the platform. Moreover, the Proficloud.io Service Store offers – thanks to well-known web-shop features – full transparency on functionalities and pricing models when booking Smart Services. All of this is integrated in a highly available cloud environment that always complies with the highest security standards available. What are you waiting for? Convince yourself!

Phoenix Contact Smart Business GmbH is the centre of excellence at Phoenix Contact for cloud services and data analytics in industrial automation.

A growing team of currently more than 30 employees located in Berlin, Bad Pyrmont and India creates standardized and scalable software-as-a-service solutions – so-called Smart Services – to empower small and mid-sized companies to take full advantage of digitization and Industrial IoT.

The core competencies of Phoenix Contact Smart Business:

Cloud technology, data analytics, software services

Cloud-based services based on Industrial IoT technologies enable users to gain an overview of the status of their application – from anywhere and at any time. By using various algorithms for forecasting, optimizing, and analyzing, users of Proficloud.io and Smart Services manage operations and maintenance processes as efficient as possible by reducing downtimes and optimizing redundant workflows – across devices and across locations.

About Phoenix Contact

Phoenix Contact is a globally present, Germany-based market leader. Our group is synonymous with future-oriented components, systems, and solutions in the fields of electrical engineering, electronics, and automation. A global network across more than 100 countries and 17,600 employees ensure close proximity to our customers, which we believe is particularly important.

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