

Predictive Analytics with ODIN

ODiN FACTS



Approx. **100** new **PLANTS** being prepared

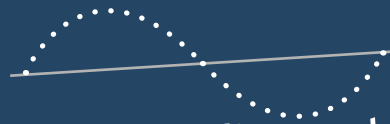
Operations

in **11**
countries



High sampling rate
of up to

1000 Hz



11 million measurements/day at a plant



faster

Up to

50%

maintenance

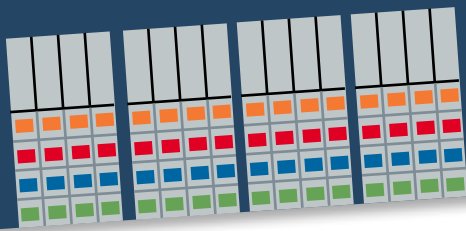
Currently

27

plants **ONLINE**



IoT gateway with up to
56 connections



Sensor packages with more
than **20 sensors**



PREDICTIVE ANALYTICS WITH ODiN

The world is developing at an extremely fast pace. People want the best products and the latest technologies. As such, there is growing demand for improved and efficient production processes. But things that seemed impossible only yesterday are in fact possible today. For example, it used to be the case that a production plant had to suffer a breakdown before repairs would be carried out, but these days smart systems can detect a fault before it has even occurred. This process of detecting faults early on is aided by our cloud-based platform called Online Diagnostic Network or ODiN for short.

05 Predictive Analytics

06 Machine Learning and Big Data

07 ODiN System Structure

08 Hardware Components - Sensor Technology and IoT Gateway

09 Example Applications

10 Implementation: Example of a Hydraulic Press

11 ODiN Analytical Service as Cloud Solution

12 Additional Service Contracts

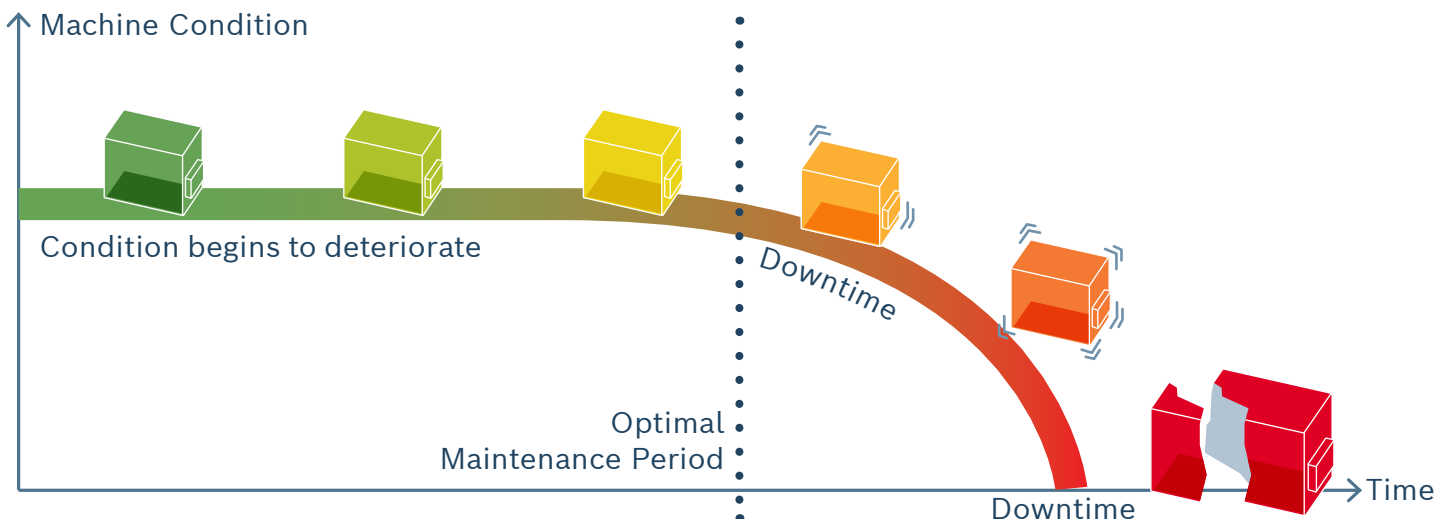
Predictive Analytics

As a smart solution for the implementation of predictive analytics, ODin is an important component of modern production processes. With the help of predictive analytics, assumptions can be made based on a component's latest wear-related data.

The aim of predictive maintenance is to prevent unscheduled downtime and hence minimize any related maintenance costs, all of which can be accomplished with predictive analytics. In order to achieve this, suitable data from the system are first of all collected via the sensor technology, securely transferred to the cloud and stored there. The specific time of the likely failure is not automatically predicted. Algorithms scan the data for abnormalities, whereupon an expert assesses them and sets out any further action to be taken, where necessary. We inform you in advance so that you can make preparations, ready for maintenance work to be carried out, and thus ensure that it is carried out more efficiently. This could mean replacing a hydraulic pump at the weekend, for example, giving you sufficient time to purchase the spare part and minimizing any disruption to production.

THE BENEFITS

- Reduction of downtime costs
- Increase in efficiency and product quality
- Prevention of complete production outage
- Reduction of storage costs
- No additional IT infrastructure required thanks to cloud solution



Machine Learning and Big Data

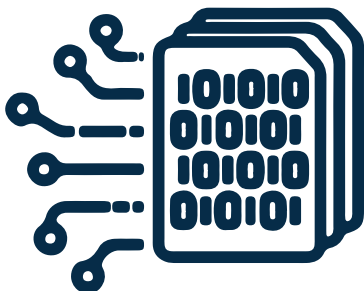
In order for predictive analytics to work, a suitable infrastructure is required so as to be able to store, analyze and visualize huge amounts of data. As such, methods such as machine learning and trend analysis are used.

Big data is crucial to the success of future business models in the Internet of Things (IoT). This is absolutely key to being able to manage large amounts of data that exceed the capacity of conventional data processing applications.

Something else which lays the groundwork for predictive analytics to be carried out is machine learning, an artificial intelligence methodology whereby knowledge is generated based on “experience.”

This enables machines to “learn,” similarly to the way humans do, from large amounts of sample data and thus recognize familiar data patterns and identify unfamiliar patterns. During the learning process, the machine is fed with sample data for building libraries and recognizing patterns. These models are used to arrange new data in established categories. The models improve with each and every data set.

A distinction is made here between monitored and unmonitored learning. Monitored learning works with the help of reference data that are defined either as good or bad in advance. With unmonitored learning, however, no such reference data are used and instead the system simply identifies a trend and automatically categorizes the data.



Machine learning helps humans by taking very complex tasks (such as analyzing dynamic data and classifying numerous parameters, etc.) off their hands. Machine learning systems work faster, are more accurate and are automated.

The correlation between big data and machine learning is that big data increases the accuracy of machine learning as the more training data that are available the more precise the systems will be.

ODiN System Structure

A major advantage of predictive analytics is the early detection of changes in the condition of a machine. But how does it work with ODiN?

ODiN is a cloud-based service which comprises analysis via the ODiN platform, operation of the user interface (account), monitoring, support with reporting, and the provision of advice and recommendations.

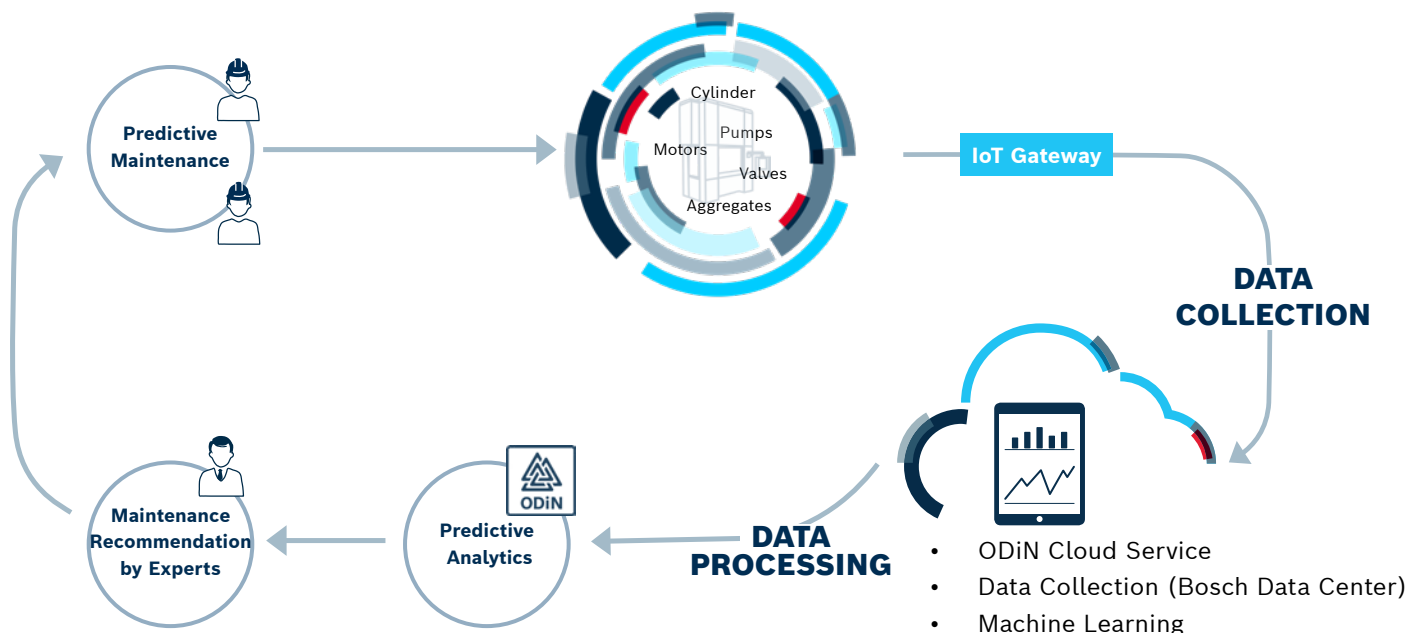
HOW DOES OUR SYSTEM WORK?

First of all, each component's condition is captured and recorded via sensors in a system and transferred to the ODiN cloud via an IoT gateway with the help of a mobile communications router equipped with a pre-configured SIM card. In order to ensure a secure connection and data security, the data are stored and processed in Bosch's own data center. The collated machine data are analyzed for anomalies with the help of ODiN whereupon our experts conduct an assessment and then draw up a status report and provide a maintenance recommendation. Potential fault

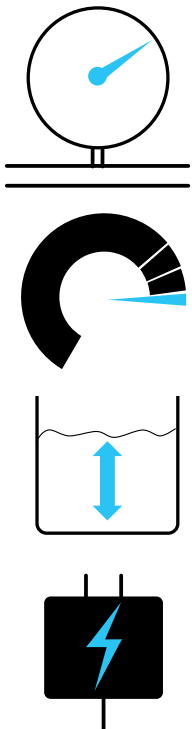
patterns are monitored and detected early on with predictive analytics. You are informed in advance so that you can determine the best time for the maintenance work to be carried out and can ensure that it is carried out more efficiently. Combining the analytical service with other Bosch Rexroth service contracts will increase machine availability tremendously.

Advantages of predictive analytics with ODiN:

- Secure data connection
- Unidirectional connection
- Data security
- Comprehensive, stress-free package



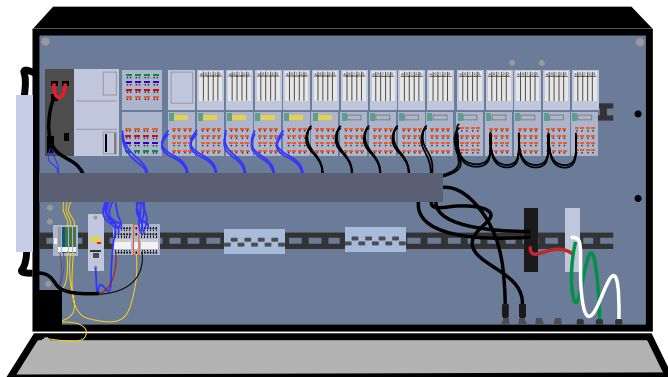
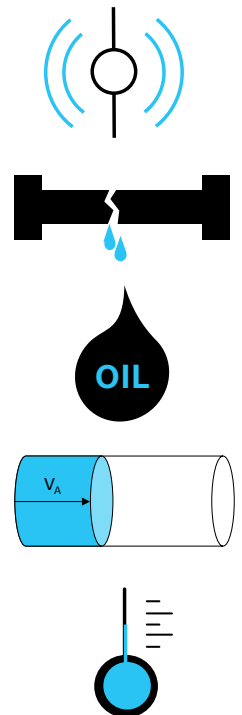
Hardware Components – Sensor Technology and IoT Gateway



As a smart solution for Industry 4.0, ODiN requires various different software and hardware components in order to be able to collect, process and analyze data. The sensor technology and the DAQ box (DAQ = data acquisition) are in particular crucial for the collection of data.

Parameters such as pressure, temperature, tank level, oil cleanliness, flow and current can be measured with the help of our customized, application-specific sensor packages. The sensors connected to the unit being monitored capture the necessary data and send them to the IOT gateway. There are two DAQs to choose from here: whilst both have a sampling rate of 1 kHz, they have a different number of possible inputs. As such, depending on the number of sensor connections, we will recommend either the gateway with 24 or the gateway with 56 analog current inputs. Pre-processing is carried out in the IoT gateway whereupon the data are sent to the cloud via an external router.

Once the data have arrived, they can be analyzed and then assessed by our experts.



- DAQ box with 56 inputs and a sampling rate of 1 kHz

HOW WILL YOU FINANCE THE HARDWARE?

There are two options for financing the hardware. The first option is to purchase the hardware (sensors, gateway and router, etc.) so that you own it. The second option is the subscription model whereby you pay monthly costs and Bosch Rexroth provides you with the hardware for the term of the contract. With this model you don't own the hardware during the contractual term or thereafter.

Example Applications

The power unit equipped with a complex sensor package is the main element of a hydraulic system. Extensive knowledge of this system is required in order to be able to monitor it effectively.

The electric motor, hydraulic pump, tank, oil cleanliness and filter need to be monitored for an informed, qualified statement to be made concerning a power unit's state of health. The cooling and the accumulator can also be included as an option. Bosch Rexroth can provide its own application-specific sensor packages for these components of a hydraulic power unit.

With regard to oil monitoring, for example, we recommend monitoring the dirt particles, the water content and, optionally, the air content in order to be able to achieve meaningful results.



► Example power unit

WHAT SENSOR TECHNOLOGY IS USED?

Oil cleanliness

- Particle counter
- Water content sensor
- Oxygen content sensor



IMPORTANT NOTE:

Monitoring with ODiN is recommended for all of a system's non-redundant components. It is also recommended for machines with redundant components, where the oil would be contaminated in the event of a failure.

Example: System without pressure filter

- The pump failure contaminates the system and may, for example, damage the valves or cylinders

Implementation: Example of a Hydraulic Press



► Example hydraulic press

A hydraulic press system involves several individual machines, apparatuses or devices working in unison. An important component of this is the power unit of which the electric motor, hydraulic pump, tank, oil cleanliness and filter are monitored.

What are the important factors with regard to the monitoring of an entire press for ensuring that an informed, qualified statement can be made regarding its state of health?

On account of the installation position of the main cylinder of a deep drawing press, maintenance is very time-consuming which means that unscheduled downtime can incur high costs. Another aspect of the main cylinder is the non-redundant design in the press. It therefore makes sense to monitor the cylinder with ODiN in order to be able to schedule maintenance for it. As such, the cylinder can be replaced during non-production time, resulting in faster maintenance and lower (consequential) costs.

WHAT IS MONITORED?

Main drive:

- Press speed
- Pressure peaks
- Positional accuracy
- Power units
- Cylinder pressures and actual values
- Manifold
- High-response valves

Transfer:

- Linear guides
- Drives

Valve

- Command values
- Actual values
- Pressures
- Temperature

ODiN Analytical Service as Cloud Solution

Electronic data processing is increasingly attracting attention these days on account of digitalization. More and more companies are recognizing the advantages of cloud-based services. Why is this also the best option for ODiN?

As an automated solution, ODiN detects anomalies using data analysis and depicts them in the form of a graphic. In addition to the system, our experts conduct daily monitoring.

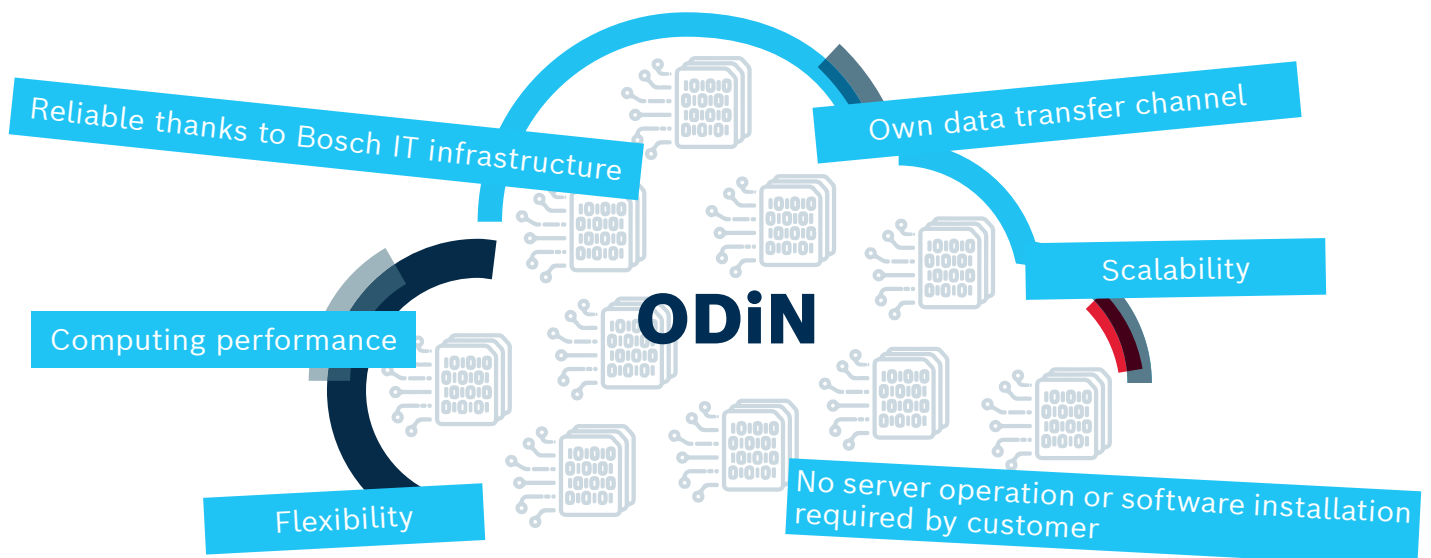
After an anomaly has been detected, the specialists analyze the monitored system in detail and issue a maintenance recommendation in good time. They draw up a detailed status report with possible recommended actions and plan with you the best time for the maintenance to be carried out.

As such, you benefit from daily monitoring by ODiN, regular quarterly reports and the maintenance service of our experts. The security of your data is also ensured through our cloud solution.

WHY THE CLOUD?

The main benefits of the cloud are shown in the graphic below.

It means that you don't have to worry about data security or data storage. As the cloud is always up-to-date there is no need for you to worry about security updates. No remote access is required as the data are sent directly to the cloud via a secure connection and the analysis results are accessible from anywhere with the help of our web interface. Thanks to the Bosch IT infrastructure, you don't have to worry about tasks such as server operations or software installations. You benefit from high-speed and high-quality analyses and better monitoring.



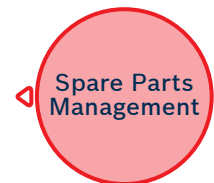
Additional Service Contracts

ODiN itself is a complex service with a broad range of options. However, in order to enable you to maximize the availability of your system, we offer optional additional service contracts.

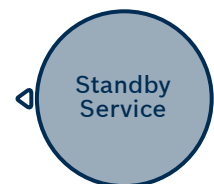
You can discover how “healthy” your system actually is with our fitness check. After this service has been provided, our experts recommend measures to prevent unscheduled downtime. As a result, your production process will be more reliable and you will be able to plan better for the future, plus you will also benefit from the best possible introduction to the world of IoT and predictive analytics (ODiN).



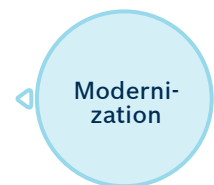
We can help you to improve your production scheduling. With the help of our recommended courses of action (ODiN) you can manage maintenance work and hence your production processes more efficiently. The right spare parts will be available at the right time thanks to our spare parts management!



Our standby service means that you will always have access to our field service at the right time in order to be able to quickly and accurately replace any defective components. In conjunction with our spare parts management, the field service immediately provides you with the relevant spare part. Thanks to ODiN, anomalies can be detected early on and maintenance work can be scheduled in good time.



Is your system still not ready for Industry 4.0 or ODiN, but purchasing a completely new system would be too expensive? Bosch Rexroth can provide you with a cost-effective alternative in the form of proficient modernization. We can provide you with professional advice on the technical modernization of dated components.



Bosch Rexroth Corporation

Corporate Headquarters
14001 South Lakes Drive
Charlotte, NC 28273
Telephone (800) REXROTH
(800) 739-7684
info@boschrexroth-us.com
www.boschrexroth-us.com