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MindSphere for Predictive Maintenance

Solution brief

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Predictive maintenance uses insights gained through operational transparency and advanced analytics to proactively manage asset health and performance. Instead of using run-to-failure and time-based maintenance approaches, which are inefficient and can cause serious mechanical failures, manufacturers monitor real-time data, analyze key performance indicators (KPIs) and performance metrics, and predict when an asset or part needs service. By eliminating scheduled maintenance and reducing unexpected failures, predictive maintenance maximizes asset availability, reduces costs and increases productivity.

How it works

MindSphere for Predictive Maintenance provides early detection of asset defects and other conditions that can lead to faults. By connecting to automation and production assets to collect real-time operational data, the solution proactively identifies when a breakdown or failure may occur.

Based on historical data, the baseline patterns and condition thresholds of a part are established for healthy equipment behavior. From this, models are built for individual assets with the specific variables that indicate the state of its health, such as levels of:

- Vibration
- Temperature
- Cycles
- Load
- Pressure

These models are deployed in real time and are compared with the real-time behavior of a machine. If a deviation from the healthy state occurs, the system identifies the root cause of the anomaly or defect: the major variables responsible for the deviation. Then alerts are sent and may recommend corrective actions.

These health models can be created on one machine and deployed to a fleet of the same assets. Additionally, multiple

Challenges

- Establish the cause of quality and production issues
- Reduce unnecessary, costly downtime
- Provide visibility into the health of remote machines

Solutions

- Use MindSphere Predictive Learning to identify root-cause machine issues
- Use Asset Manager to determine machine performance
- Use Fleet Manager to provide an overview of global assets

Results

- Predict the timeframe when a machine will need maintenance
- Increase production and save costs by eliminating poorly timed maintenance
- Remotely monitor machines with an open, cloud-based platform

Solution focus

models can be built for an asset. The need for different models for one machine could be based on:

- Equipment lifecycle, such as before and after refurbishment
- Seasonal conditions that may impact performance
- Raw-material feeds

Core components

The MindSphere for Predictive Maintenance solution is made up of several components.

Predictive Learning

MindSphere Predictive Learning allows data scientists to build prediction models using machine learning techniques, which enable companies to optimize product quality and reduce potential field failures and performance issues. With the Data Science

Workbench module in MindSphere Predictive Learning, users have access to the Zeppelin notebook for authoring models. Managed instances of Zeppelin notebook are provided for exploring, training and visualizing models. These notebooks have prepackaged learning offerings, such as TensorFlow, Keras and Theano, as well as distributed machine learning packages such as MLlib. There are options to configure and select what compute power is needed so users can easily explore and build models on big data.

The MindSphere Predictive Learning workspace out-of-the-box (OOTB) functions enable users to quickly explore, transform and analyze big data without the need for any additional scripting. This enables users to create new datasets that can be applied in another workspace or in the notebook, which helps domain experts and data scientists to collaborate more efficiently.

Asset Manager

Asset Manager is a component of MindSphere that gives you the ability to model the structure of an industrial process. It creates this model using assets (digital representations of machines), types (preconfigured

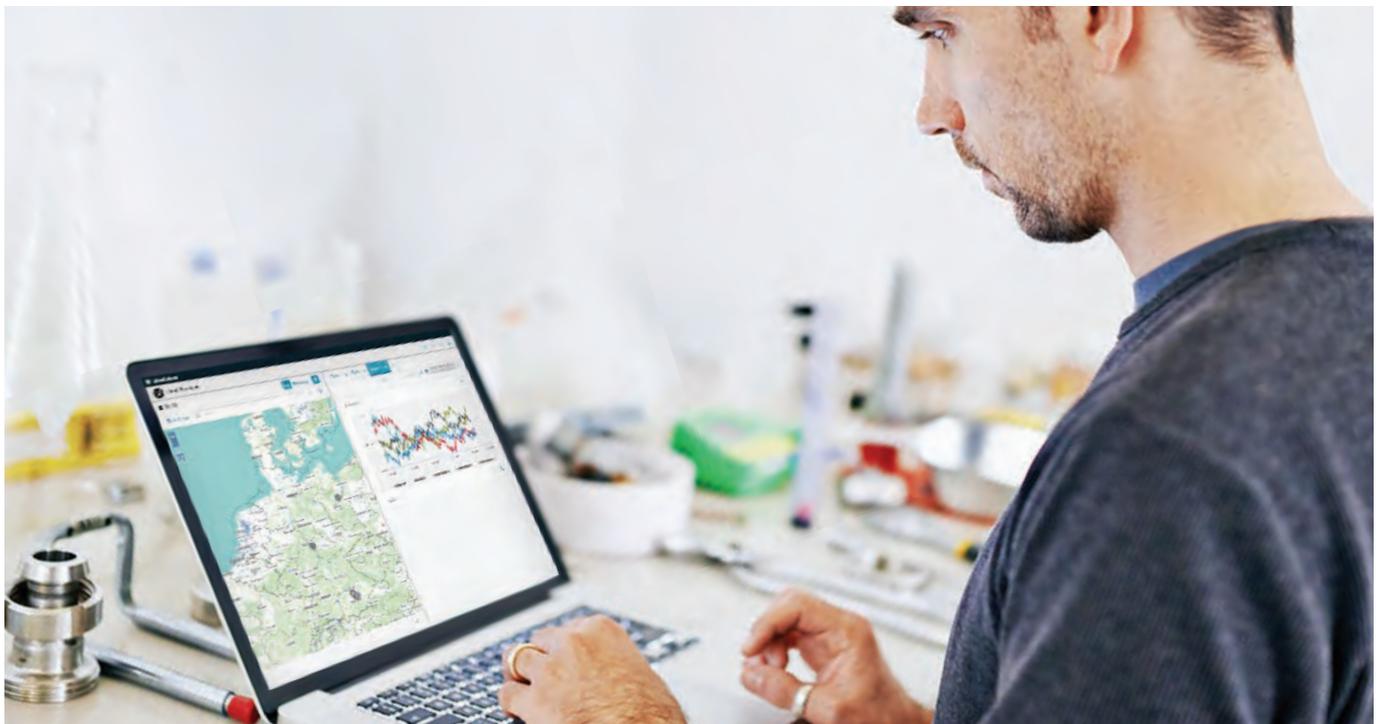
templates for assets) and aspects (components with an asset). By using the Asset Manager configuration, you are able to track specific data sources that are relevant to determining machine performance.

Fleet Manager

Fleet Manager is another component of MindSphere designed to give you an overview of your assets. With Fleet Manager, you can define your assets' properties and configure events that you wish to know about, as well as specify the preferred type of data visualization.

Your production configuration is mapped 1:1 thanks to individual floor plans and a map view. Built-in alerting capabilities allow you to set alarms tied to specific KPIs, which in turn allows you to immediately know when an asset's performance is outside acceptable parameters. A map view allows you to see each of your assets as a pin, with colors to indicate there's relevant information, a warning, or an error associated with a particular asset.

The solution also uses MindSphere Analytics Services, a collection of application programming interfaces (APIs) for industrial time-series data. By using



MindSphere Analytics Services, you can leverage your machine data to create insights that drive significant performance improvements. The APIs included are:

- **KPI calculation:** Use sensor data to establish KPIs that help you determine machine performance quickly, including availability, utilization rate, number of deviations from optimal performance range, number of stoppages per unit of production and more. This capability is available for the analysis of both offline batch data and online analysis of streaming data
- **Anomaly detection:** Rapidly detect abnormal or unexpected behavior of machines and processes that can be indicative of poor performance. Clustering-based anomaly detection enables you to infuse greater human interaction and domain knowledge
- **Event analytics:** Use statistical analysis to visualize the top 10 asset failures that are used to identify potential problems. Over time, modify the API to detect error patterns in event logs

- **Signal calculation:** Handle common missing value strategies such as removal and interpolation. The API calculates a descriptive summary of a sequence of signal values, and if required, derives new signal values by shifting, smoothing and transforming the original ones
- **Signal validation:** Detect the most common issues in time-series data. Some of the functions included are: range check, spike alert, step alert, noise alert and bias alert. The API can also be used for optimizing data quality
- **Trend predictions:** Forecast machine performance using both linear and polynomial regression. Use seasonality and trend removal during data analytics preprocessing

Getting started

The MindSphere for Predictive Maintenance solution builds on asset management, condition monitoring and asset performance management. To deploy it, you must already be continuously collecting and analyzing real-time asset health and performance data from a machine's sensors and devices. Devices and assets need to be connected and streaming data to a centralized cloud infrastructure – the MindSphere platform.

Looking ahead

Once MindSphere for Predictive Maintenance is running in your factories, the next step in optimizing performance is prescriptive maintenance. Instead of just considering threshold limits and baseline deviations, MindSphere for Predictive Maintenance considers other factors: future workloads, workflow impacts, factory conditions, energy peak times and more. Using artificial intelligence (AI) and machine learning models, it not only tells you what will fail and when, it provides possible remedial actions to take based on financial and operational ramifications. So MindSphere for Predictive Maintenance not only suggests when and what maintenance to perform, but it can also reschedule your production line.

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