Predictive Maintenance

COMPETITIVE ANALYSIS

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Introduction

The aim of this document is to present the competition in the Predictive Maintenance business. Predictive maintenance (PdM) techniques are designed to help determine the condition of in-service equipment in order to predict when maintenance should be performed. Predictive maintenance is one of the leading use cases for the Industrial Internet of Things and Industry. Our recent analysis suggests that the market for predictive maintenance applications is poised to grow from $2.2B in 2017 to $10.9B by 2022, a 39% annual growth rate.

Because our purpose is to identify entrants on the market and what they are offering we try to find few sources which serve a number of different companies. Based on that sources we can make few categories that will help us in the further analysis. At the end, there will be analyzed the top 5 companies in more detailed SWOT analysis.

Competition Segmentation Overview

After the extensive research that we conducted we came up to large number of competitors in the Predictive Maintenance (PdM) sector. In order to make the picture clearer, in continuation of this document, we will categorize the companies that are working in this field into several categories and sub-categories.

We identified the following categories:

1. **Large Companies (Corporations) that offer PdM as part of their large pallet of products** and services (SIEMENS, IBM, SAP, GE,). They offer full-package PdM, comprised of implementation of the software and hardware, analytics and services;
2. **Startups that offer software platform which is comprised of multiple applications** among which is the Predictive Maintenance (C3 IoT, Uptake, SpaceTime Insight, Warwick Analytics, Avantis PRiSM, Falkonry). Their platforms gather Big Data, analyze it, predict events and recommend actions.
3. **Only Software Companies (Startups) that offer PdM solution** (Presenso, Senseye, Fiix, DataRPM, Cassantec, Precognize, PREDIKTO). Their software use machine learning technologies that automatically finds early signs and problems and predict the anomalies.

4. **Companies that offer Software and Hardware together** (Sensosurf, Konux, MONIXO, Artesis, Altizon). They offer sensor integration to the equipment and PdM platform that will use the data from the sensors.
5. **Only Hardware companies that offer measurement systems and sensors for PdM** (PCB Piezotronics, gulplug, Easy-Laser, PRÜFTECHNIK,).

Below, competitors from all segments will be analyzed in more detail separately. The analysis will start with the first segment, Large Corporations and will continue with order from above presented segmentation.

Large Corporations

In their offer this companies have large number of products and services used in number of industries, but also offer Predictive Maintenance.

Siemens is a leading technology and sustainability company that has been on the market for more than 165 years. They have more than 350 thousand employees as of 2017 and have 289 plants worldwide. They also operate with office buildings, warehouses, sales offices and research facilities.

The cutting edge technology in intelligent maintenance is already here. Predictive maintenance makes it possible with collection and analysis of data to predict the best possible moment for maintaining and replacing plant components.

The key concepts and advantages of this software are the following:

- Minimizing downtime: the software helps avoid unnecessary shutdowns of factory machines. Similar features include: Remote Systems as Managed Appliance, SIMATIC Remote Services, SIMATIC System Audit and Asset Optimization Services.
- Optimizing the supply of spare parts: managing spare parts and reducing costs. This includes Asset Optimization Services.
- Cutting energy costs: identify hidden savings potential in your machines and plants. This includes Energy Analytics.
- Increasing system availability: This includes SIMATIC System Audit.

- Overview of the global installed base: high level of transparency for your machines worldwide. This includes Fleet Management Services.
- Personalizing your service package: customizing service packages to fit the customer needs. This include: Repair Service Contracts, Motor Management Program and SIMATIC PCS 7 Lifecycle Services.

IBM is a global technology and innovation company headquartered in Armonk, NY. It is the largest technology and consulting employer in the world, with more than 375,000 employees serving clients in 170 countries.

Predictive maintenance software solutions from IBM access multiple data sources in real time to predict asset failure or quality issues so your organization can avoid costly downtime and reduce maintenance costs. Driven by predictive analytics, these solutions detect even minor anomalies and failure patterns to determine the assets and operational processes that are at the greatest risk of problems or failure. This early identification of potential concerns helps you deploy limited resources more cost effectively, maximize equipment uptime and enhance quality and supply chain processes, ultimately improving customer satisfaction.

Predictive maintenance solutions from IBM can help your organization: predict where, when, and why asset failures are likely to occur, quickly identify primary variables as part of root-cause analysis process, minimize product quality and reliability issues to meet customer delivery schedules, optimize spare-parts inventory to reduce inventory costs associated with stockouts and overstocks, predict warranty claims to increase customer satisfaction, enhance sales and operations planning to reduce operations costs, inform upcoming issues to planning and budgeting teams prior to costly event failures occurring.

As a market leader in enterprise application software, SAP (NYSE: SAP) helps companies of all sizes and industries run better. From back office to boardroom, warehouse to storefront, desktop to mobile devices, SAP empowers people and organizations to work together more efficiently and use business insight more effectively to stay ahead of the competition.

Powered by SAP HANA in-memory technology, the solution analyzes large volumes of sensor data (such as temperature, vibration, or rotation speed) and issues an alert long before a machine breaks down. Combine sensor data with business information in your CRM, ERP, and enterprise asset management (EAM) systems – and move from reactive to predictive maintenance and service.

Predictive maintenance solutions from SAP can help your organization: avoid costly disruptions by predicting equipment malfunctions before they happen, use insights from sensor data to improve product quality and customer satisfaction, optimize resource management by sending technicians with the right parts at the right time, prevent unplanned downtime and schedule maintenance at a time that is least disruptive to operations, prototype and launch new IoT initiatives in 3 months or less – with the SAP Leonardo jump-start program.

There are two types of deployment of the server:

1. SAP Predictive Maintenance and Service, cloud edition

   With the use of Internet of Things (IoT), the collected data allows real life monitoring of the machine so users can be warned at the first sign of an unusual activity, thus avoiding unnecessary service costs.

   From a technical perspective, SAP PdMS CE uses: SAP Fiori UX and SAP Cloud Platform to build the applications, SAP HANA for storage and analytics, SAP Cloud Platform Internet of things for device connectivity, Integration to SAP Smart Business to monitor KPIs and SAP Cloud Platform Integration for integration to other cloud or on-premise applications.

2. SAP Predictive Maintenance and Service, on premise edition

   The on premise edition offers a perpetual license model based on the number of measuring or sensor points that are configured in the system. A base package is available for smaller scale implementations. This edition leverages SAP HANA as a hot storage for fast queries and predictive calculations, as well as SAP Sybase IQ for storage of IoT Big Data.

   From a technical perspective, SAP PdMS OPE uses: SAPUI5 and SAP HANA XS Advanced (XSA) to build the applications, SAP HANA Platform for hot storage and analytics, SAP IQ

for optional cold storage, SAP Device Management for IoT by Telit and SAP Plant Connectivity (PCo) for device connectivity, and SAP HANA IoT Integrator by OSIsoft.

Founded in 1982, with headquarters in Boston, GE is one of the leading electrical and electronic companies. With more than 10 000 employees, GE follows the innovation path in the industry.

Asset Performance Management(APM) balances cost, availability and risk in order to provide optimal performance at a lower cost. The benefits of APM are many:

- Reliability Management: predicting equipment issues before they happen which includes: Predictive Analytics, Case and Collaboration Management, Knowledge Management, Root Cause Analysis, Reliability Analysis.
- Compliance & Integrity Management: ensuring asset integrity and compliance by monitoring changing risk conditions. It includes Machine & Equipment Health plus: Hazard Analysis, Safety Lifecycle Management, Risk Based Inspection, Inspection Management, Thickness monitoring.
- Asset Strategy Optimization: with intelligent asset strategies optimize and lower risks and costs. It includes Machine & Equipment Health plus: Reliability centered, Strategy management and Lifecycle cost analysis and Financial and risk simulation.
- Machine & Equipment Health: this segment is the milestone of the APM system and is the binding element of other offerings. Machine & Equipment Health includes: Connectivity, Data management, EAM integration, Condition monitoring, Data analysis and visualization, Criticality analysis, Event management, Recommendation management.

Multiple Application Startups

Usually startup companies that have software platforms that offer other correlated solutions apart from Predictive Maintenance. Their platforms gather large amounts of data, use machine learning to analyze it, based on that make predictions and recommend further actions. In this category we will process four of them.

Founded in 2009 by Thomas Siebel under the name C3 Energy, the company rebranded into C3 IoT in early 2016. Based in The Redwood City, California, the

startup at the beginning targeted only energy companies and with the rebranding, expanded its focus by developing a variety of next-gen applications for horizontal markets such as CRM, predictive maintenance and sensor health, and verticals including manufacturing, oil and gas, retail, computer software, discrete manufacturing, aerospace and telecommunications.

Currently C3 IoT offers the following products:

- C3 IoT Platform;
- C3 IoT Applications;
- C3 IoT Data Lake;
- C3 IoT Ex Machina.

The company had very successful year with revenue increasing 65% from the previous and the bookings increase for approximately 600% year over year. Also, C3 IoT received one of 2016's largest IoT funding rounds of $97 million led by TPG Growth, followed by Series E financing led by Breyer Capital and was awarded Glassdoor's 2017 Best Place to Work Award.

In 2014, Brad Keywell and Eric Lefkofsky founded Uptake in Chicago, Illinois. Uptake is a predictive analytics SaaS platform, that helps customers to gather huge amount of data, whether the data came from IT systems or sensors in factories or on equipment and then provides analytics and intelligence, using the inputs to build computer models that can forecast the need for action before its occurrence. The platforms is used across different global industries from Agriculture, Aviation and Rail and Construction, to Energy, Healthcare, Retail and Mining industries. From operational point, Uptake platform is comprised of several applications that will be presented below:

- Equipment Monitoring;
- Diagnostic Troubleshooting;
- Cybersecurity;
- KPI Dashboards;
- Action Recommendation;
- Event & Condition Prediction;
- Rules & Alerts;

Uptake business model is based on creating partnerships with big companies like CAT and Berkshire Hathaway Energy subsidiaries, which than use Uptake to sell as a service to their clients.

With that, Uptake share the revenue with the partner and do not have to build a big sales force. Currently, Uptake has been valued to over $2 billion. In addition to the predictive analytic work, Uptake include beyond.uptake which is company's philanthropic and civic innovation arm.

SpaceTime Insight is founded in 2007 by Krishna Kumar, Jagadeesh Macherla and headquartered in San Mateo, California. SpaceTime Insight is end-to-end Warp 6 platform that provides enterprise analytics applications that delivers data collection and correlation, operations analytics and cutting edge visualization and action tools for asset-intensive industries. In June 2016, the company acquired IIoT startup GoFactory in order to broaden its spectrum with capabilities in cloud services, connected assets and mobile applications.

The platform components are:

- Data Integration and Correlation;
- Operations Analytics;
- Visualization and Action;

Furthermore, in addition to the platform, SpaceTime Insight offers following services:

- Professional Services;
- Hosting and Managed Services;
- Data Science;
- User Interface/User Experience Design;
- Training;
- Support Services;

Warwick Analytics is an analytics firm founded in 2011 and based in London, United Kingdom. They provide automated predictive analytics for CX, early warning, predictive maintenance, warranty and root cause analysis. The original purpose of the company was to provide early warning for manufacturing issues with heterogeneous datasets, but since then they expanded the technology into other sectors such as transportation, finance, life sciences, retail and consumer products. The company's software is based on sophisticated computer algorithms, developed at WMG at the University of Warwick, after decade of academic research.

They offer two products PrediCx and SigmaGuardian, both based on their Big Data Platform known as A3. Our point of interest is the SigmaGuardian product, which presents early warning

and prevention system for predictive maintenance and warranty processes. The capabilities built in are:

- Detect anomalies;
- Predict both issues and anomalies;
- Simple sets of business rules which can be understood to help identify root causes and/or predict the issues and anomalies;
- Dynamic alerts and alarms when anomalies occur in order to provide early warning so that preventative action may be taken;
- Clusters of error logs, alarms and notes of operators or engineers who maintain equipment – mined from ERP and Asset Maintenance databases as well as live operational systems;
- Groups of semantically similar events and issues for more valid signals;
- The output is a simple set of actionable recommendations with their predictive scores and impact.

Only Predictive Maintenance Software Startups

Predictive Maintenance is the main specialty of this companies. They offer only PdM Software that use machine learning technologies that automatically finds early signs and problems and predict the anomalies. Below are presented three of them Presenso, Sensye and Fiix.

Presenso was founded in 2015 by Eitan Vesely, Deddy Lavid and Dr. David Almagor and currently is headquartered in the Matam industrial zone in Haifa, Israel. The software is part of the ongoing Industry 4.0 transition and is one of the pioneers in the in the application of Artificial Intelligence for predictive asset management.

Using Deep learning and Machine Learning algorithms, Presenso's analytic engine autonomously learns how similar groups of machines behave. The engine creates internal bonds between events and components inside the machine and between the machines and various systems on the industrial sites. In that way the software is able to detect abnormal events, to find correlations between such events and ultimately predict evolving failures. Once Presenso detects the evolution of an abnormal pattern, the system generates alerts about the potential upcoming failure and provides valuable information about the remaining time to the failure and its origin point. The

company's mission is to alert many plants before a machine breaks down, thereby reducing the cumulative stoppage time to a minimum. The system can also recommend solutions to current issues based on its analysis of previous occurrences.

Founded in 2014 and headquartered in Southampton UK, Sensye is producing sensor data that predicts machine failures. Simplicity is one of their key components.

It is an automatic software specially designed for industrial companies with the purpose of predicting machine failure and maximizing overall equipment effectiveness. The software is cheap and easy to use because it is based in the cloud (this means no installation is needed) and can be accessed on a phone or tablet. Sensye answers a few critical questions such as what is the Remaining Useful Life of the machine and how to reduce machine downtime. By using machine learning, big data, industry 4.0 and IoT (Internet of Things) Sensye predicts potential failures and recommends best possible course of action.

Fiix is a small company that creates cloud based maintenance software. The company is founded in 2008 and based in Toronto, it provides CMMS (computerized maintenance management system) solution to companies with different sizes and industries.

Their CMMS software helps maintenance teams keep a record of all assets they are responsible for, schedule and track maintenance tasks and keep a historical record of work they perform. Furthermore, the software can be installed on client's computers system or can be cloud based.

Fiix can be used for production maintenance, facility maintenance, fleet maintenance and linear asset maintenance.

Predictive Maintenance Software and Hardware Companies

The following companies offer Software and Hardware solutions combined. They first apply their sensors on the client machines and based on the data collected from the sensors their software is able to analyze and predict events.

Sensosurf is a small startup company founded in Bremen, Germany in 2015. Their mission is to connect microsystem technology with mechanical engineering. The company builds sensors that can fit on metal, synthetics and ceramics. The sensors are

ten times thinner than a human hair but highly resistant so the clients can use them in different conditions. The equipment is fit with various sensor structures, high ruggedness, ultra-thin integration space and smart sensor readout.

Their solution includes:

- Integration - Component specific sensor designs and sensor applications;
- Interpretation – Machine learning algorithms data interpretation;
- Information - variety of information – application dependent and tailored to client's needs.

Their technology enables predictive maintenance, load detection, quality monitoring and system optimization.

Konux is a company from Munich, founded in 2014, that combines engineering and software. They make sensors and use high tech data analytics to determine the lifespan of machines. With the help of cloud storage, companies can safely and easily access their information. Their approach includes the following steps:

- Measure – Apply smart sensor systems to identify the exact information's that are necessary;
- Connect – Wireless transmission of the data into secure cloud storage;
- Analyze - Apply artificial intelligence and machine learning for data analysis;
- Act - Results of the analytics are presented in a user-friendly way on the platform Andromeda, or integrated into client tools.

One of the many services this company provides is: switch monitoring, asset monitoring, rolling stock monitoring, anomaly detection, predictive analytics and customized hardware.

Monixo is a small startup, founded in 2013 and located in Toulouse, France. They provide complete, efficient and reliable solution to effectively anticipate failures. They integrate industrial IoT, cloud storage, machine learning and data analysis all which can be accessed on a web or mobile application. Their solution have the following architecture:

- Industrial IOT – Connecting cluster of high-precision, autonomous, wireless and two-way sensors;

- Cloud - In charge of the provision and storage of data, it interfaces third party's systems through its APIs;
- Machine Learning - Automatic data analysis and prediction with the patterns of extraction;
- Applications - Acquired data and analysis are made available on the Monixo platform via the web and mobile applications.

One of the many sectors that Monixo can implement its services are: manufacturing, transportation, energy and infrastructure.

Artesis is a Turkish based company that has taken part in projects from different fields such as helicopter engines and gas turbines. Their services range across the metal processing, pulp and paper, water, utilities, food and beverage, automotive, chemical and petrochemical, defense industry and much more.

The Artesis intelligent predictive maintenance system incorporates different types of services. Installation, training and remote monitoring are a crucial part of the service that assure that the hardware and software run without interruption.

Condition monitoring, predictive maintenance, asset management, electrical engineering, operations, information technology and senior management are additional areas which Artesis serves its clients.

Founded in 2012 and based in California, DataRPM is a company that uses Artificial Intelligence to automate predictions of machine failure.

The name of their software is CPdM (Cognitive Predictive Maintenance). It is available on cloud and on premise hardware. CPdM delivers prescriptive and descriptive analytics. The key steps that this software uses are:

- Collection of data.
- Identifying the key features.
- Finding patterns and anomalies.
- Identifying influencing factors and predictors.
- Building predictive models.
- Giving predictive maintenance insights.

CPdM is specially designed to prevent breakdowns, reduce maintenance cost, minimize risk and optimize inventory and personnel.

Only Hardware for Predictive Maintenance Companies

The companies below do not offer Predictive Maintenance Solutions but measurement hardware systems that enable the PdM. This is why we put this category last, for example below are presented two companies.

Founded in 1967 in Depew NY, PCB Piezotronics started as manufacturer of piezoelectric quartz sensors, accelerometers and associated electronics for the measurement of dynamic pressure, force and vibration. First big success of the company was introduction of the of microelectronic signal conditioning circuitry within these sensors. The continual growth and constant investment in facilities, machinery and equipment, lead to constant broadening of the product offering.

Nowadays, the company is a designer, manufacturer and global supplier of accelerometers, microphones, force, torque, load, strain and pressure sensors, as well as the pioneer of ICP technology. Their products are used by design engineers and predictive maintenance professionals worldwide for test, measurement, monitoring and control requirements in automotive, aerospace, industrial, R&D, military, educational, commercial, OEM applications and many more.

Gulplug is stratup, founded in 2014 in Grenoble, France. The company provides a disruptive technology based on magnetic electrical connection with a smart energy sensor in order to plug and measure easier, faster and safer.

Gulplug aim is to help plant and building managers to monitor and save their energy consumption and also to predictive maintenance on their machines. Their connected services use innovative energy sensors which rely on a battery less and wireless disruptive technology from Schneider Electric. The integration is quick and easy and it can be applied even while the machine is running and with no disruption to the building or plant. Schneider Electric, Fenwick-Linde and Bonduelle, are some of their clients that already implemented the systems. They have reduced their overall electrical consumption by 8% to 12% for a payback within the year.

SWOT - Top 5 Companies

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Some of the content has been hidden due to confidentiality.