Predictive Maintenance and Service
An Overview Presentation
Business Development Expert Manufacturing und Industry 4.0
October 27, 2014
Agenda

Trends

Challenges

Solution

Scenarios
Trends
The World is Connected

50 billion devices connected by 2020*

40-50% CAGR for M2M market until 2020*

1/5 price of sensors, microprocessors & wireless technologies today vs. 4 years ago**

**Source: Economist Intelligence Unit – “The Rise of the Machines” – 2012
# Predictive Maintenance and Service – Business

<table>
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<th>Players</th>
<th>Value</th>
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| **OEMs:** Manufacturer of digitally empowered equipment providing new service business models to asset owners e.g. selling performance, remote service, etc. | - Higher margin service offerings  
- Improve product quality  
- Reduce warranty costs  
- Enabling of new business models around the asset |
| **Dealers and Service Providers:** Add-on services for asset owners or on behalf of OEMs. | - Optimize services delivery  
- Improve service efficiency |
| **Owners and Operators:** Asset owners optimizing asset performance by monitoring asset health e.g. condition based or predictive maintenance, predictive quality, etc. | - Increase asset availability  
- Reduce unplanned downtimes  
- Improve overall quality and safety |
Challenges
Predictive maintenance techniques help determine the condition of in-service equipment (by also using sensor/telemetry data and alerts) in order to predict when maintenance should be performed. This approach offers cost savings over routine or time-based preventive maintenance, because tasks are performed only when warranted.

The main value of Predicted Maintenance is to allow convenient scheduling of corrective maintenance, and to prevent unexpected equipment failures. The key is ‘the right information in the right time’.” (Wikipedia)
Valuable Insight Lost in Disparate Information Flows & Disconnected Databases

- Business & Product Data
- Technical & Operational Data
- Unstructured Data

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Predictive Maintenance and Service

Common Objective for Customer, Dealer & OEM
Maximum Equipment Uptime and Minimum of Maintenance Costs

Information and Analysis Tools

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Solution
Predictive Maintenance and Service
A key building block for improved asset performance

Sense

Predict

Act

- Create work order
- Change product specs
- Alter maintenance schedule
- Propose spare parts
- ...

Sensor Data

Business Data

Environmental Data

Pattern and Root Cause Analysis

Predictions
Traditional Service vs. Optimized Service

- Operator
- Technician
- OEM Support
- OEM Technician
- Spare parts & tools
- Remote Service Engineer
- Real-time condition monitoring
End-to-End Process for Maintenance & Service

Remote Maintenance and Service

*Increase effectiveness*

- IT/OT Connectivity
- Condition Monitoring Remote Service
- Fault Pattern Recognition
- Asset Health Prediction

SAP solution for maintenance/service

*Increase efficiency*

- Create Maintenance or Service Order
- Schedule Order
- Execute Order on Mobile Device
- Visual Support

Watch: [https://www.youtube.com/watch?v=UlpGDrSmq38](https://www.youtube.com/watch?v=UlpGDrSmq38)
Predictive Maintenance and Service – Vision

Telemetry Data
- Sensor measurements
- Geospatial data
- Diagnostics
- Events
- Performance metrics
- Battery status

Business Data
- Sales contract
- Warranty information
- Maintenance/Service history
- Customer profile
- Dealer events
- Cost and risk

Third party data ...
- Structured and unstructured
  - e.g. weather forecast

SAP HANA

- Asset health monitoring
- Early warnings to prevent downtimes
- Prioritize maintenance and service activities
- Optimized warranty and spare parts mgmt
- Benchmarking
- Design improvements
Predictive Maintenance and Service on SAP HANA

- **Business Data Import**
- **Business Process Integration**
- **Analysis & Exploration**
- **Prediction Engine**
- **Notification Server**

**Data Models**
- Recordings
- Weather
- Equipment Data
  - Temperature
  - Voltage
- Telemetry Data Import
- Any Text Based Data Analysis

**Unified Data Model**
- Data Models
- Prediction
- Notification

**Flexible Modeling**
**Visual Rules Designer**
**Predictive Analysis**

**Notification**
**Server**

**Prediction**
- Predict health
- Create actionable insights

**Actionable Insights**

**Telemetry Data Import**

**Unified Data**

- Equipment Data

- Unstructured Data
  - Recordings
  - Weather

- Any Text Based Data Analysis

**Data Import**
- Business Data Import
- Business Process Integration

**R&D Engineer**
**Service Coordinator**
**Asset Manager**
**Warranty Manager**

**User Interface**

**Mobile App**
**Web App**
### SAP Predictive Maintenance and Service, Cloud Edition

**Planned Capabilities**

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<tr>
<th>Dashboards</th>
<th>Lists</th>
<th>Graphs &amp; Charts</th>
<th>Maps</th>
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<tbody>
<tr>
<td>Machine Mgmt</td>
<td>Rules &amp; Alerting</td>
<td>User Mgmt</td>
<td>Vibration Analysis</td>
<td>Integration services</td>
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</table>

#### SAP HANA IoT Edition

- Connectivity Platforms (by Telcos)
- 3rd Party Device Cloud
- Communication Networks (by Telcos)
- IoT Connector
- Devices

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Scenarios
Defect Pattern Identification

Identification and prioritization of machine failure pattern for product improvement

Based on claims, damage reports, business and configuration data
Combining in an iterative approach
- Visualization (parallel coordinates, multi-dimensional scaling)
- Mapping of expert knowledge into HANA and
- Statistical analysis (text clustering, association analysis, decision trees)

Improved product quality at lower costs
- Quick identification of new defect patterns
- Guidance for root cause analysis
- Reduction of manual work in quality management
- Cost reduction & increased customer satisfaction
Machine Health Prediction

Sense & predict machine health supporting the solution provider transformation

**Using machine data**
- Predict breakdowns via decision trees
- Calculate energy consumption pattern profiles with k-means clustering
- Model domain expert knowledge in SAP HANA with decision tables
- Provide 360° view on machines with real-time calculation of KPIs from ERP and telemetry data

**Scale and improve service business by**
- Better transparency of current condition
- Machine health prediction from historic data
- Optimize field technicians scheduling, including failure predictions
Vehicle Health Prediction

Improve manufacturing quality, service planning and customer satisfaction

**Single point of access to all related business and technical information**

- Integration of SAP HANA and Hadoop for reporting and predictive analytics
- Association rule mining and regression tree learning to correlate production rework and customer satisfaction data
- SAP HANA/R data mining and data visualization based on survey - and manufacturing data sets

**Improved prediction of upcoming warranty cases**

- 80% accuracy based on vehicle diagnosis and previous warranty claims
Emerging Issues

Faster product improvement and early failure prediction to reduce downtime

**Single SAP HANA based platform that combines sensor and warranty data**
- Analysis of equipment's telematics data
- Detection of potential issues and relation to equipment's service and warranty data using text mining, association analysis and HANA database capabilities
- Shorter detection-to-correction cycle

**Reduced warranty costs**
- Quick identification of potentially defective behavior of fleet
- Creation of evidence packages as input to root cause analysis
- Machine warranty cost reduction & improved up-time
Vibration Analysis

Identification of health fingerprint based on vibration analysis

**Monitoring of machine health using failure pattern**
- A 360 degree view of a machine by integrating technical machine and business data in a flexible data model in HANA
- Trend analysis and pattern comparison on vibration and process data

**Better machine utilization & reduction of warranty costs**
- Detect emerging dangerous vibrations
- Change from manual, reactive vibration analysis process to an automated, proactive process
- Improvement of machine uptime and reduction of maintenance costs.
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Alert

Severity: !
Description: Gear Input Speed exceeding warning value
Processor:
Triggered: Jun 2, 2014, 2:00:02 AM
Measuring Point: Bowl Speed NT

Status:
Alert ID: 2519
Last Processor:
Last Changed: Jun 2, 2014, 2:09:02 AM

Machine

Machine Type: SEPARATOR
Machine Subtype: MSI 350-01-772
Fabrication Number: 17332-512
Order Number: 1452123220 / 002000

Connection Status:
Last Service: Feb 1, 2014
Next Service: Jun 3, 2014
Machine Condition Monitor


Jun 4, 2014
11:36:00 AM

- Bowl Motor Amperage: 4.86 A
- Bowl Speed NT: 9.77 RPM
- Gear Input Speed: 94.63 RPM
- Separator starting: No
- Separator flushing on: No
- Separator postrunning: No
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Alert set in process
Predictive Maintenance and Service - Solution

Internet of Things Enablement Platform
- Device connectivity
- Device management

Remote Monitoring
- Sensor data visualization and analysis
- Device alerts via flexible threshold
- Machine health fact sheets

Condition Based Maintenance and Service
- KPIs definition
- Rule based action triggers
- Seamless integration into maintenance and service processes

Predictive Analysis
- Fault pattern recognition via unstructured data
- Machine health predictions
- Root cause analysis for engineering improvements
Predictive Maintenance (Repeatable Custom Solution)
Powered by SAP HANA

Business Situation
Maintenance is responsible for keeping equipment running and avoiding unplanned downtime with its costly side effects. Basic maintenance strategies are scheduled maintenance based on simple metrics, such as time intervals, machine hours, or distances traveled, drive maintenance schedules and activities. Condition-based maintenance reflects the actual conditions of the equipment and its components. It requires that respective data is collected from built-in sensors and analyzed in order to identify any kind of problems. Consequent follow-up processes such as spare parts supply, technician visit are triggered.

Challenges
Disconnection between equipment and business processes results in higher costs:
- High operation costs due to high failure rates
- Automated gathering of relevant machine data from remote locations
- Inability to do root cause analysis and prediction decrease equipment productivity and innovation
- Poor precision of spare parts planning, results in high spare parts inventory rate
- Some parts need to be expedited at high costs

Process Innovation
- Equipment Benchmarking / Control Center: Build a control center that gives you an overview of your complete equipment in the field. Search and filter for machines via lists or maps.
- Reactive to Predictive Service: Identify problems, understand actual status, send problem notification to customer, send service technician and identify required spare parts.
- Energy Analytics: Analyze the energy consumption of machines in the field. Find anomalies or potential problems. Offer an automated utilization billing based on consumption data.

Benefit SAP HANA
- Possibility to combine business and product data, unstructured data and technical as well as operational equipment data in a unified data model
- Leverage the statistics and predictive abilities provided by HANA

Value Driver
- Reduce Operations & Maintenance Costs: Higher asset productivity with automated monitoring & notification processes
- Improve Reliability & Visibility: Increase asset availability with condition-based maintenance procedures and tools
- Improve Cash Flow: Decrease spare parts inventory rate
- Maximize Asset Uptime: Decrease unplanned outages with preventive & predictive vs. reactive maintenance

Solution
- Assessment Service with subsequent Custom Development Program (CDP)

Preview

Audience
- R&D Engineer
- Service Coordinator & Manager
- Fleet Manager
- Asset Manager
- Warranty Manager
Predictive Maintenance
Additional information

Maturity

- Assessment Service with subsequent Custom Development Program (CDP)
  - CDP project
    - Customer provides HANA system including licenses or HEC
    - Involvement of SAP CD / SAP Consulting funded by customer
    - Involvement of SAP Development
    - Outcome is a project that can be used productively for daily business
  - Co-Innovation project
    - Infrastructure and trial licenses optionally supplied by SAP Development
    - Involvement of SAP Consultants, Data scientists and Designers with Customers business users and IT
    - Outcome is a prototype. The goal is to close a follow-up CDP project to build a solution that can be used productively.

Invest/ Cost

- SAP HANA, Sybase IQ, SAP Data Services, Sybase ESP, SAP Predictive Analysis, SAP Lumira
- Data Science Services 20 – 40 days
- Hadoop Resell

Impact IT-Infrastructure

- High Availability of the systems is required
- Possibility of hosting the complete solution in the cloud (HEC)

Assets

- Lars Bastian (CVS), Bernhard Gonschorek (BTS), Oswald Wieser (Co-Innovation Development)
- Referenzen: Keaser Kompressoren,
Predictive Maintenance and Service – Benefits

For asset manufacturers / service providers:
- Improve service profitability
  - Lower service costs
  - New revenue streams
- Higher percentage of calls resolved without technician dispatch
- Higher first-visit-fix rate
- Customer satisfaction and retention
- Higher service contract renewal rates
- Enable innovative business models

For asset owners / operators:
- Higher overall equipment effectiveness (asset availability & performance & quality)
- Improve maintenance efficiency
- Lower maintenance costs
- Faster reaction to alarms and failures
- Higher mean time between failure
- Lower mean time to repair
Summary

- Improved Quality
- Better Visibility
- Reduced Costs
- Higher Uptime
- Increased Reliability
- Optimized Planning
- Customer Retention
- Lower Inventory
Thank You!

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