ForeSee Cluster Webinar Series

Predictive Maintenance: European success stories

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European Cluster for Sustainable Predictive Maintenance Solutions in the Factory of the Future

ForeSee is a cluster of six projects, which have received funding from the European Union's Horizon 2020 research and innovation programme under the FoF-09-2017 call.

PROPHESY PROGRAMS UPTIME UNIFIED PREDICTIVE MAINTENANCE SEREN PRECOM Predictive Cognitive Maintenance Decision Support System Z-BRE4K

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European Cluster for Sustainable
Predictive Maintenance Solutions
in the Factory of the Future

Webinar #2

Reliability and Tools, for Predictive Maintenance Applications

Professor Dr. Basim Al Najjar Linnaeus University, Sweden
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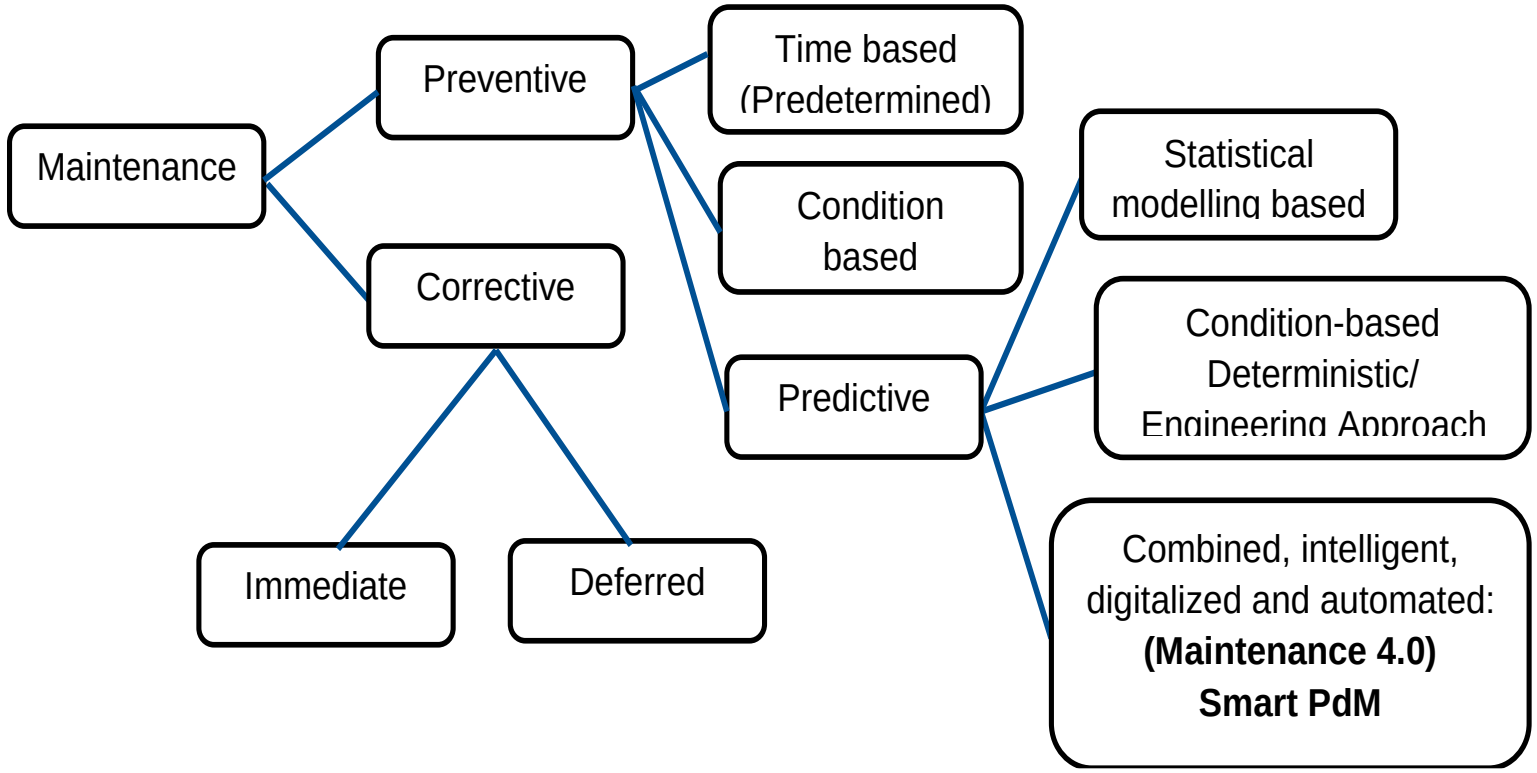
Contents

Introduction: Predictive Maintenance (PdM)

PdM with respect to:

- Accuracy
- Applicability
- Data availability
- Cost-effectiveness



PreCoM: Addressed problem and Purposes

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- **How to reduce the losses in production and maintenance** that other systems did not succeed to achieve?

PRECOM

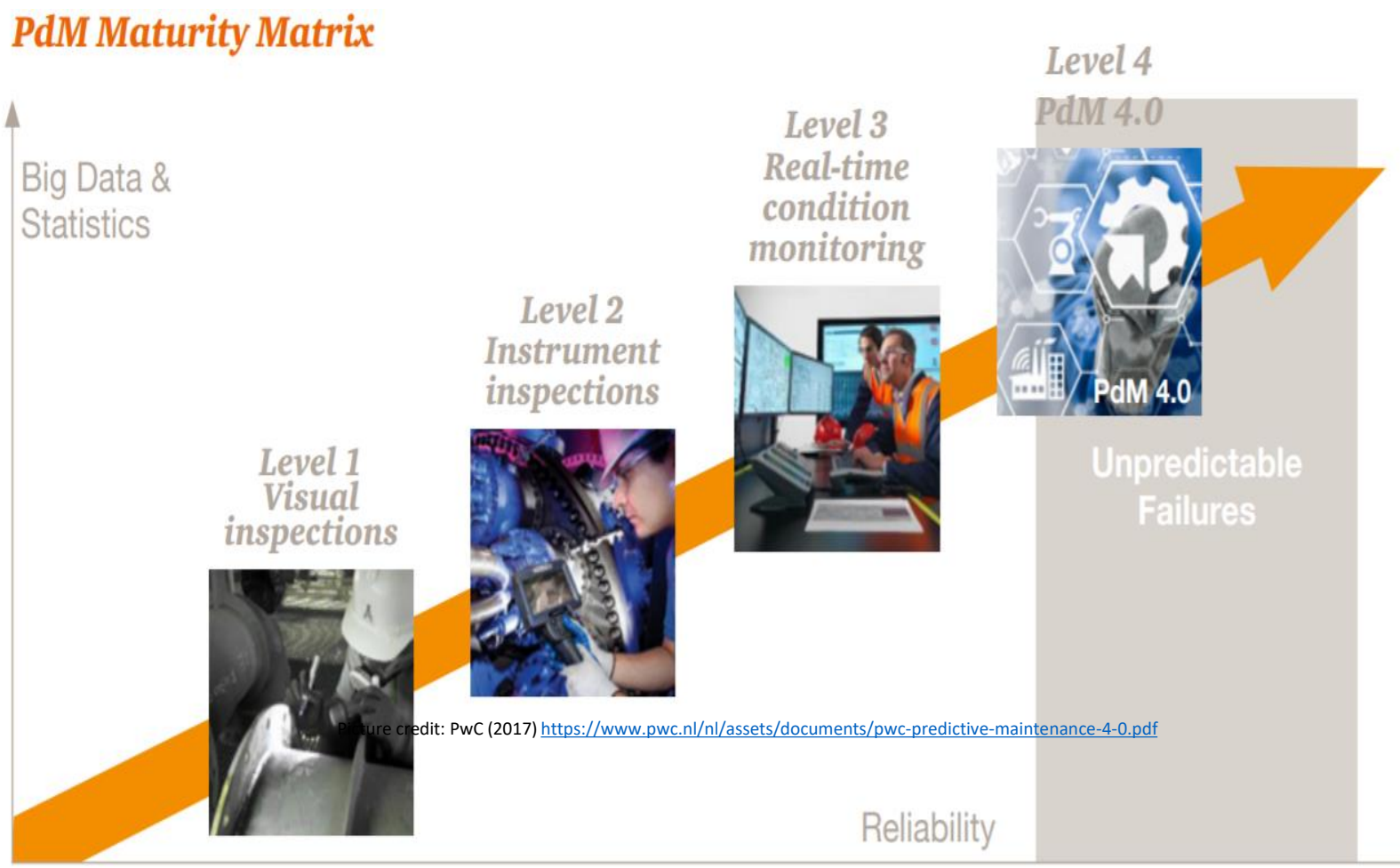
Predictive Cognitive Maintenance Decision Support System

- Development of **Predictive Cognitive Maintenance Decision Support System** (**PreCoM-system**) to improve availability and maintainability, reduce accidents and losses in energy and material cost-effectively.

Picture credit: PwC (2018) https://www.pwc.be/en/documents/20180926-pdm40-beyond-the-hype-report.pdf

PreCoM- Smart PdM platform and philosophy

- To describe reality, i.e. machine condition, we better apply a combination of:
  - **Deterministic** (what has been happened and ongoing), and
  - **Probabilistic** (what may be happened conditionally) approaches.
- Well identified, high quality and better coverage data to provide **better understanding of the real condition of a Machine – Component – Deterioration process** – More accurate prediction and Maintenance decision.



Picture credit: PwC (2017) https://www.pwc.nl/nl/assets/documents/pwc-predictive-maintenance-4-0.pdf

Tools, methods and technologies developed and utilized

- Data driven, big data and statistical models,
- Modules for automatic:
  - Data acquisition,
  - Detecting damages,
  - Localizing and assessment of damages,
  - Condition diagnosis,
  - Predicting damage development,
  - Recommending about; what, where, why and how to do,
  - Detecting deviations in the health of sensors,
  - Assessment of time to maintenance and optimizing maintenance for the whole machine,
  - Production scheduling and optimizing maintenance w r t a production schedule.

Tools, methods and technologies developed and utilized

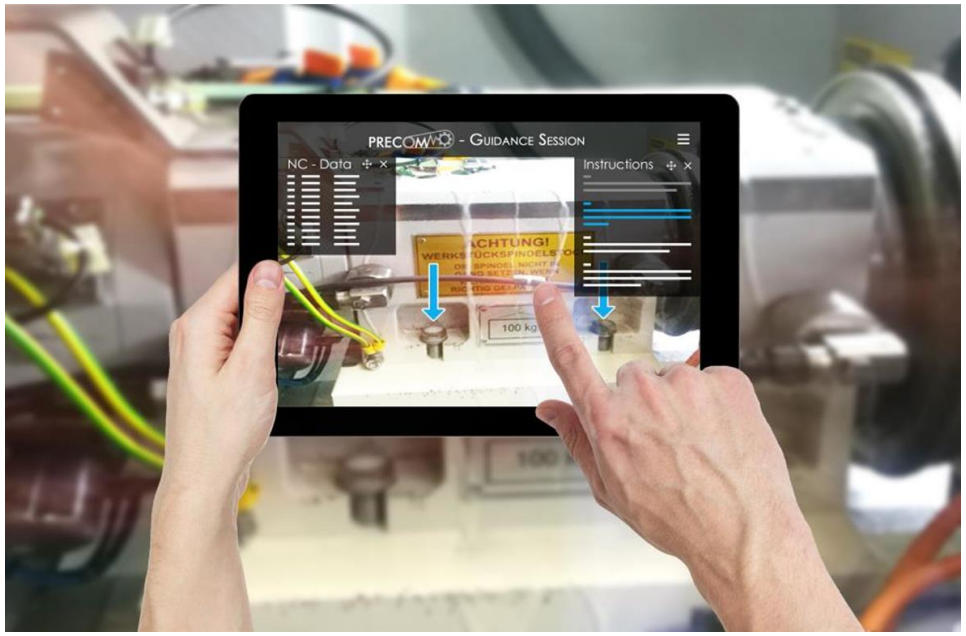
- AR and PLIV,
- Tools to digitalize manually gathered data,
- Module to provide statistics to the machine manufacturer supporting modification of new generations,
- Module to follow up and assess PdM technical and economic impact on production process,
- Common data and knowledge base,
- Common API and Cloud for communication

PreCoM key modules

- Sensing platform
- Predictive algorithms
- Production/Maintenance scheduling
- AR/PLIV

Whom utilize them

1. **Maintenance personnel** for maintaining machine condition effectively, and
2. **Production personnel** for effective and more profitable production.



Application: Case studies

- PreCoM-system is applied on four machines, in three different companies in two EU-countries (Spain and Slovakia).
- The machine condition, production, etc. have been monitored 24/7 during the demonstration period.
- Data has been collected continuously for some modules and periodically for others.
- Analysis, results and recommendations are provided directly after every measuring opportunity.
- Follow up and treatment of problems, challenges, bugs and deviations were done continuously to secure smooth performance.

Challenges and Solutions

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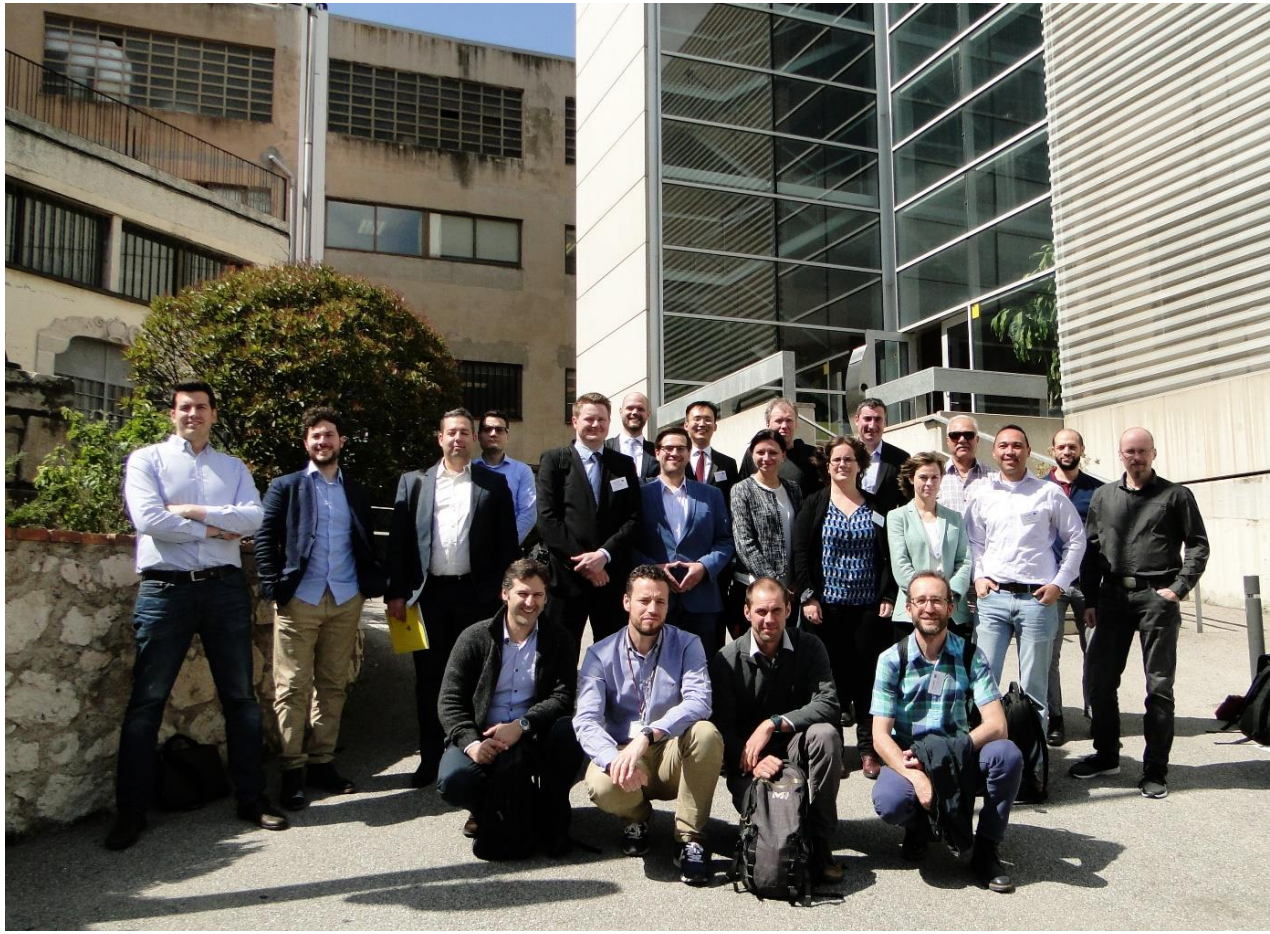
- **Communications**: 17 partners of different background, work culture, languages and specialities.
- Development of a **common understanding** of the problems addressed and purposes to meet project expectations.
- Identification and gathering of relevant, **wide coverage and high quality data**.
- Development of **common cloud/data- and knowledge base and API** to secure communication/integration of PreCoM Cloud with all hard- and software modules



We succeeded to **overcome the challenges** through:

❖ Closer, reliable and committed collaboration of PreCoM-partners.

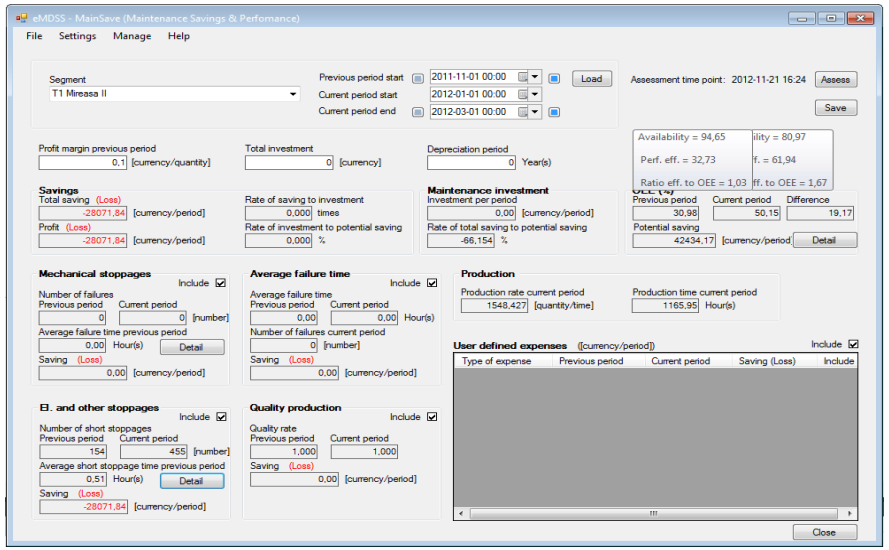
❖ Solving problems jointly in a friendly and constructive climate.

❖ Partners commitments.

Primary results

Intermediate assessment with demonstration companies concerning:

- **Accessibility**: Easy
- **Usability**: Good and Reliable
- **Impact of the PreCoM system**: Problems with components were early detected by PreCoM in two companies (it would not had been otherwise) and led to avoid production stoppages and saving costs for about 20,000-40,000 € per company.



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Reliability and Tools for PdM Application

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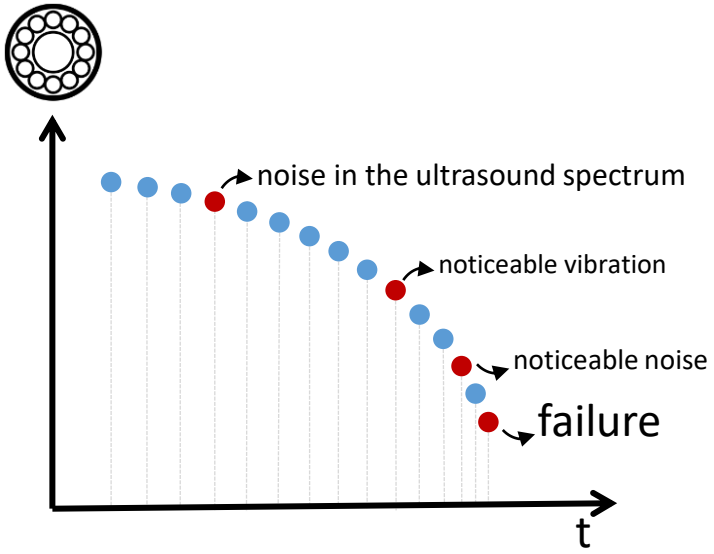
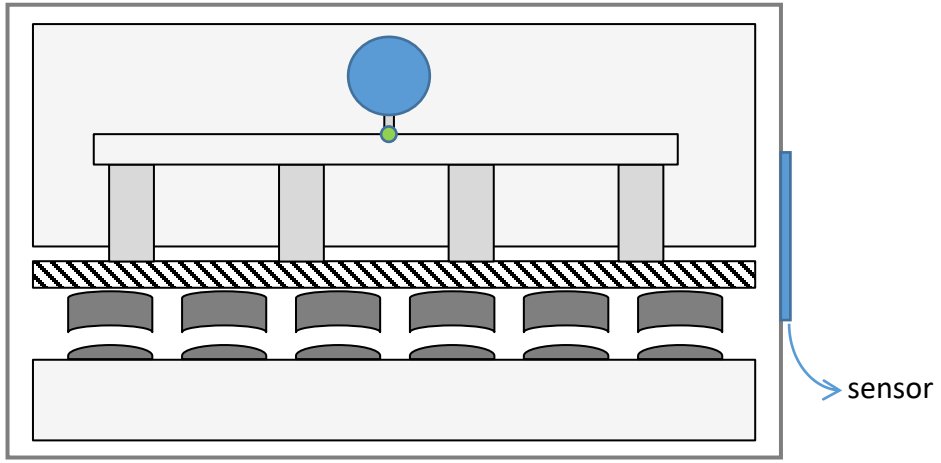
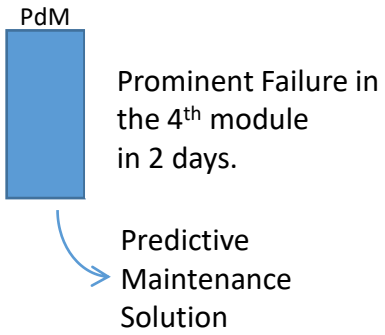
PdM relies on the existence of signs before the actual failure







Reliability and Tools for PdM Application

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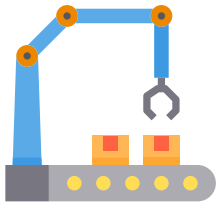
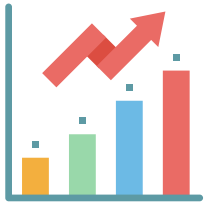
- Smart Maintenance Process



Data Collection

Data Pre-processing

Data Processing



Data Analysis

Actions Orchestration

User Feedback

Reliability and Tools for PdM Application

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- Sample of Available Tools

FETCH

TRANSFER

HANDLE

CLEAN

PROCESS

STORE

OPC UA, Woopsa, Modbus

APACHE kafka, APACHE Camel, spring Integration

INDUSTRIAL DATA SPACE, FIWARE, AUTOWARE, BLOCKCHAIN

DDQ, OpenRefine

Flink, APACHE Spark, TensorFlow

influxdb, OPENTSDB

Reliability and Tools for PdM Application

- 1st step of Data Processing

- Visit the Factory
- See demo videos/presentations
- Read Documents

Speak with the experts

- Evaluate/Filter the data
- Build training data
- Build test data

Reliability and Tools for PdM Application

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- Supervised or Unsupervised ML?

Unsupervised *learning is a type of machine learning that looks for previously undetected patterns in a data set with no pre-existing labels and with a minimum of human supervision.*

OR

Unsupervised Machine Learning?

Supervised Machine Learning?

Supervised *learning is the machine learning task of learning a function that maps an input to an output based on example input-output pairs.*

- Proactive or Reactive Maintenance?

Proactive maintenance *is a preventive maintenance strategy. The purpose of proactive maintenance is to see machine failures as something that can be anticipated and eliminated before they develop.*

OR

Proactive Maintenance?

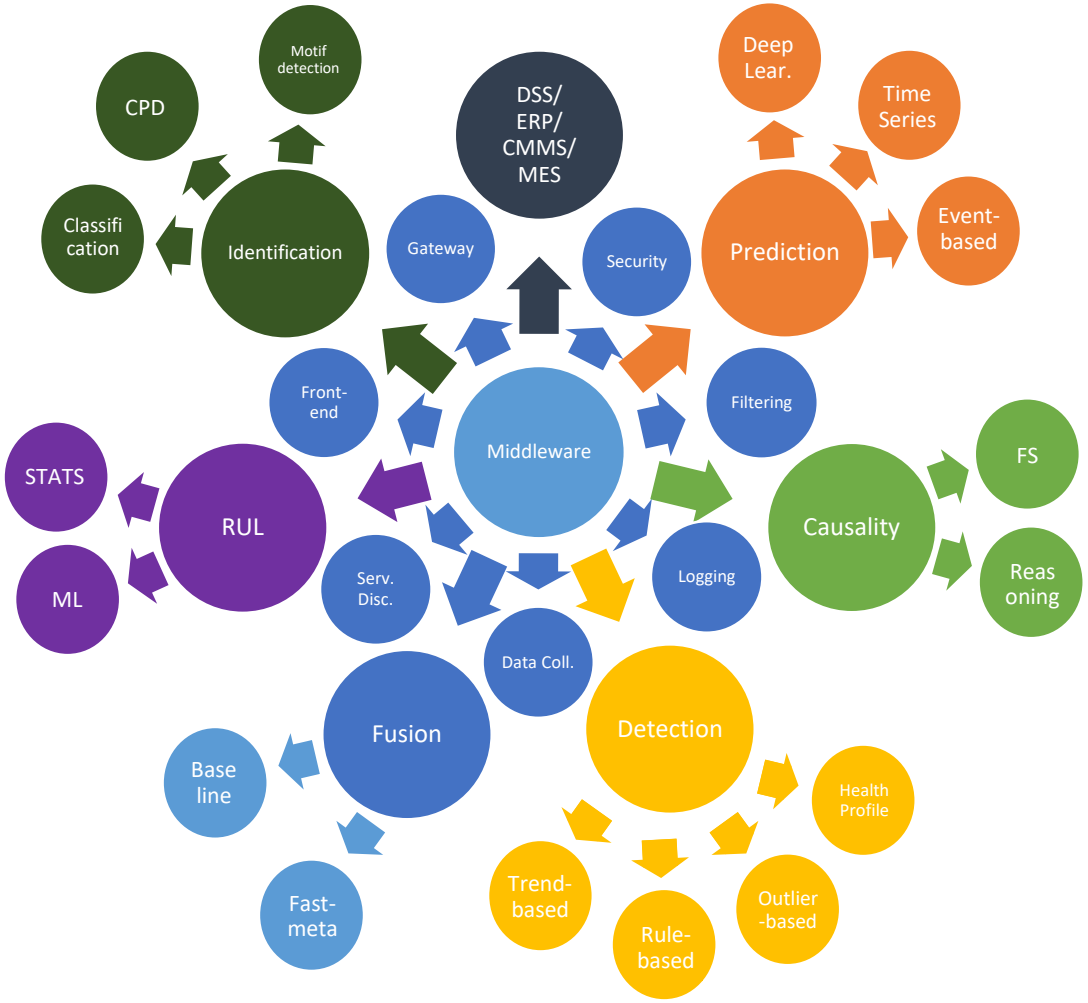
Proactive Maintenance?

Reactive maintenance *refers to repairs that are done when equipment has already broken down, in order to restore the equipment to its normal operating condition.*

<u>Should we choose?</u>

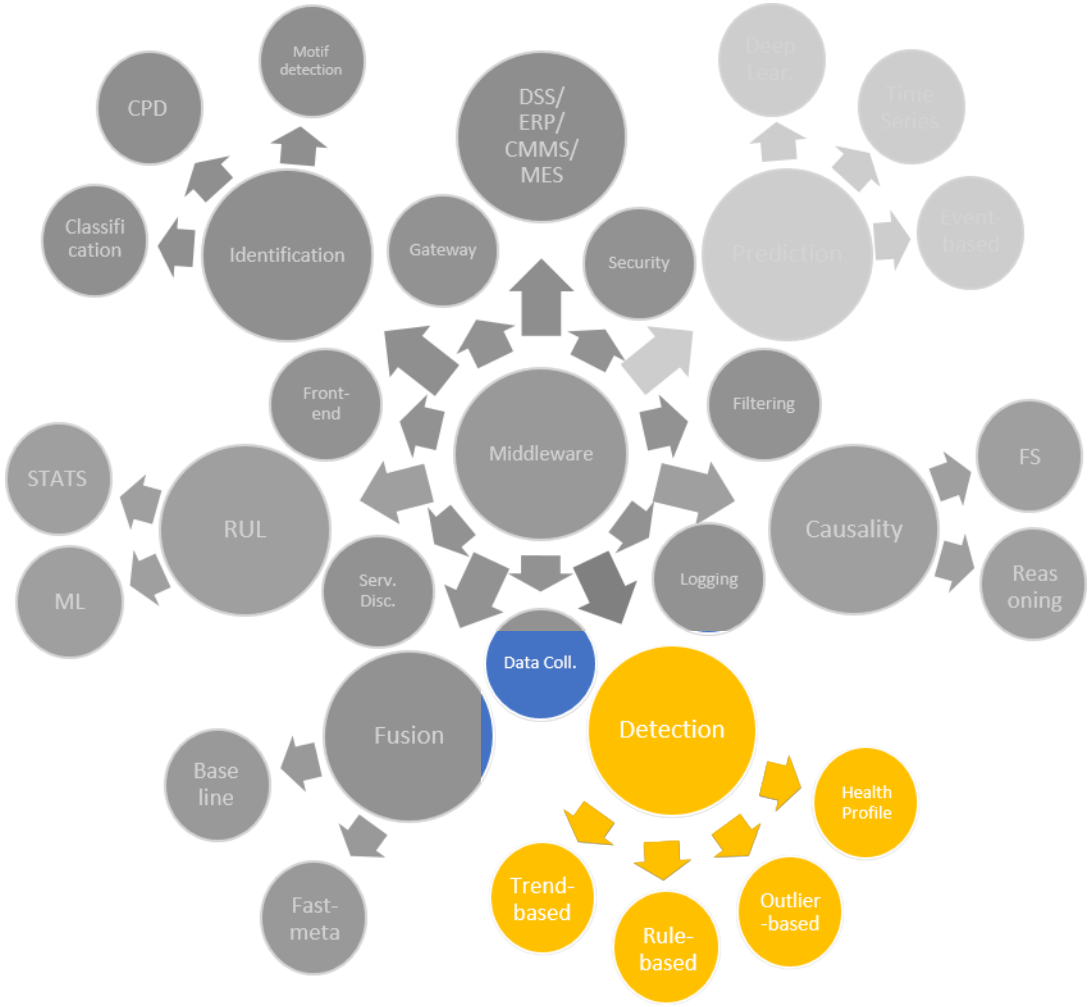
Reliability and Tools for PdM Application

- PdM Approaches



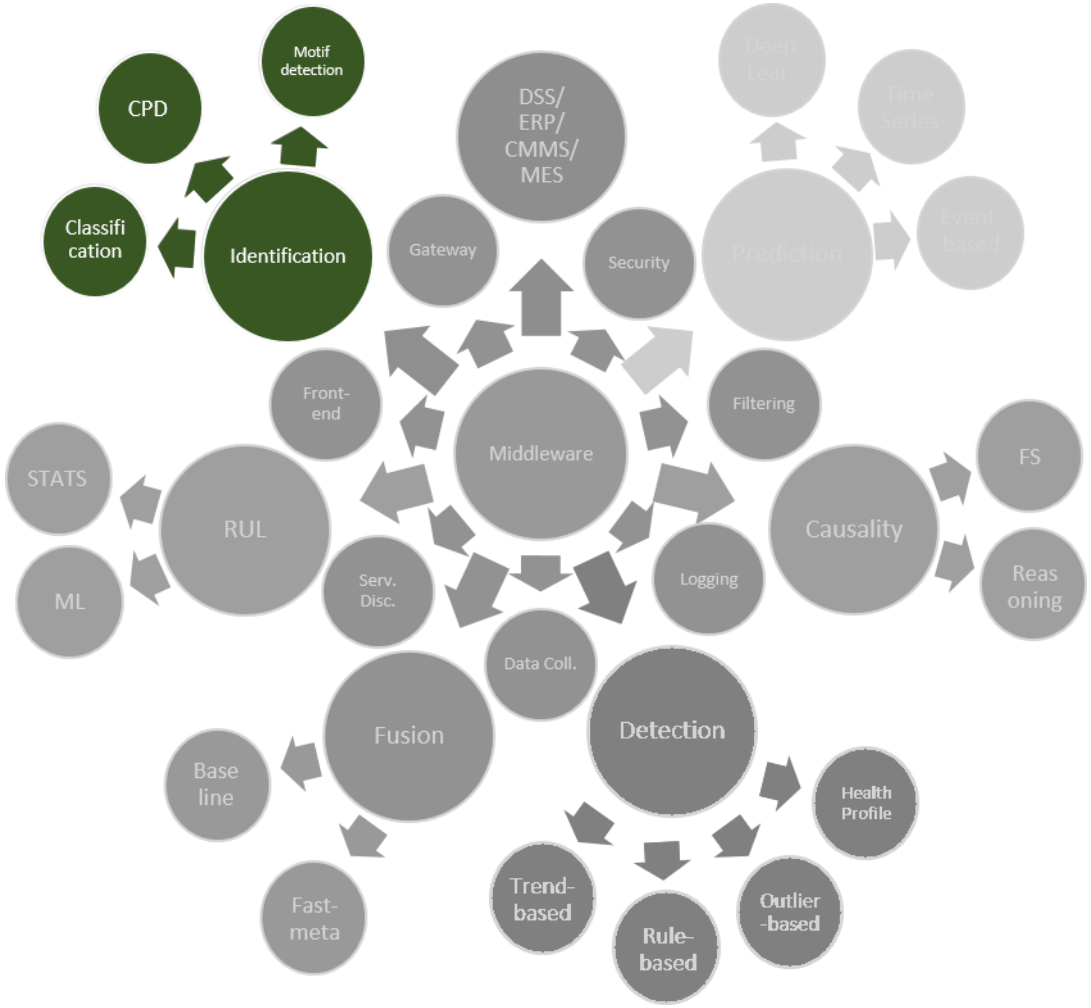
Reliability and Tools for PdM Application

- PdM Approaches



Reliability and Tools for PdM Application

- PdM Approaches



Reliability and Tools for PdM Application

- PdM Approaches

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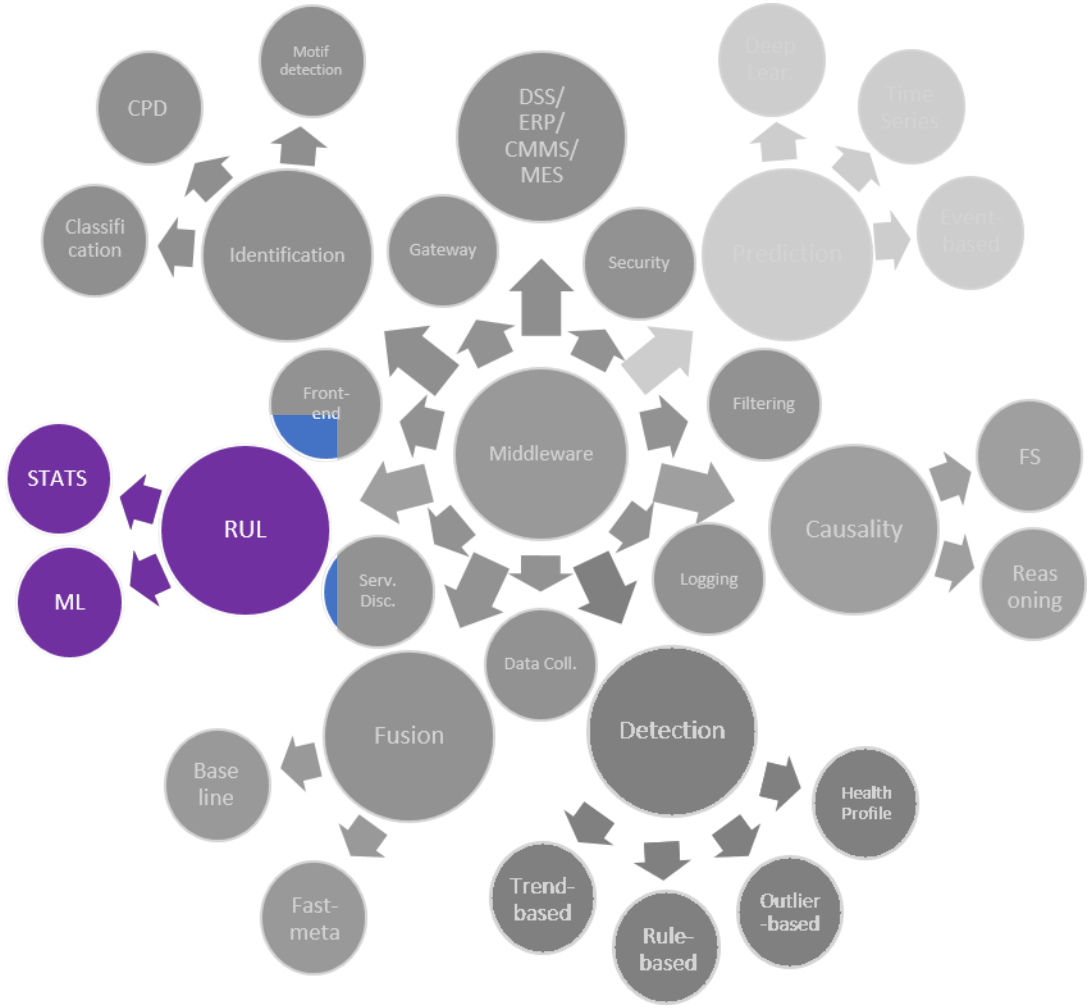

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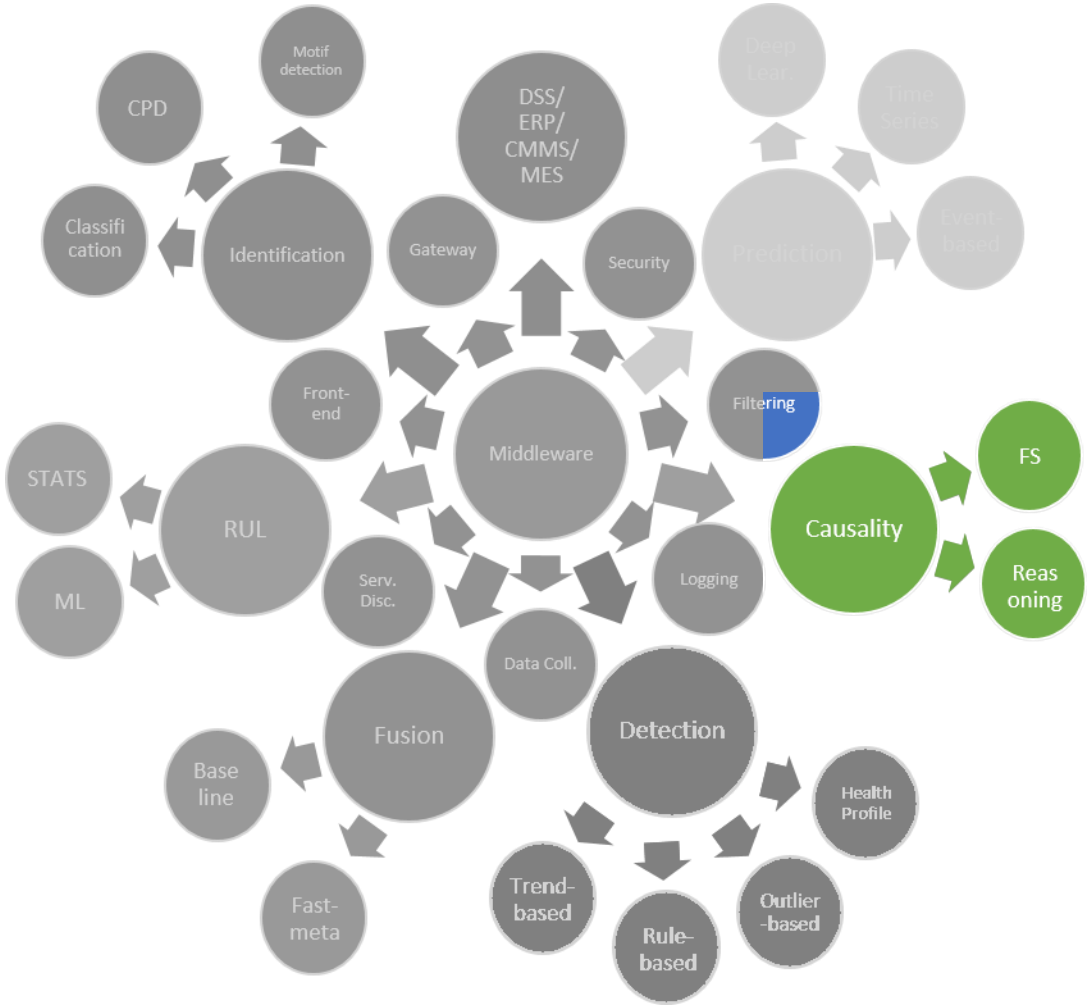

Reliability and Tools for PdM Application

- PdM Approaches

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Reliability and Tools for PdM Application

- Z-BRE4K project

a novel predictive maintenance platform to eliminate unexpected-breakdowns and extend the life of production systems.

This project has received funding from the Horizon 2020 Framework Programme of the European Union under grant agreement n° 768869

Gestamp
The GESTAMP-Autotech demonstrator will be linked to the demonstration of a Lighthouse manufacturing process FRAMETOP for the multi stage zero defect manufacturing of next generation automotive chassis.

Philips
As a complex demonstrator PHILIPS contributes a production line with cold forming tooling. On this tooling PHILIPS would like to move from preventive maintenance to predictive maintenance.

Sacmi-CDS
The SACMI-CDS use case will be related to the packaging industry. SACMI is planning to introduce a predictive maintenance service for the end user involved (CDS) within Compression Moulding machines.

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ATLANTIS ENGINEERING

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