



# VTT Operation and Maintenance

27/01/2020 VTT – beyond the obvious

# VTT – beyond the obvious

VTT is one of the leading research, development and innovation organizations in Europe. We help our customers and society to grow and renew through applied research. The business sector and the entire society get the best benefit from VTT when we solve challenges that require world-class know-how together and translate them into business opportunities.

## Our vision

A brighter future is created through science-based innovations.

## Our mission

Customers and society grow and renew through applied research.

## Strategy

Impact through scientific and technological excellence.

Established in

**1942**

**268 M€**

Net turnover and other operating income (VTT Group 2018)

**2,049**

Total of personnel (VTT Group 31.12.2018)

**Nonprofit**

Owned by Ministry of Economic Affairs and Employment

**31%**

Doctorates and Licentiatees (VTT Group 2018)

**44%**

From the net turnover abroad (VTT Group 2018)

# VTT - customized CBM solutions for production assets usage

Measuring (sensors) – Transfer (data) – Store (information) – Analyse (act)



$$f(x) = \int_0^x f'(t) dt + f(0)$$

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

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$$f^{(n)}(x) = \lim_{h \rightarrow 0} \frac{f^{(n-1)}(x+h) - f^{(n-1)}(x)}{h}$$

$$f(x) = \sum_{k=0}^{\infty} \frac{f^{(k)}(a)}{k!} (x-a)^k$$

$$f(x) = \sum_{k=0}^{\infty} \frac{f^{(k)}(a)}{k!} (x-a)^k + R_n(x)$$

$$R_n(x) = \frac{f^{(n+1)}(\xi)}{(n+1)!} (x-a)^{n+1}$$

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## NEED

- Production systems are ever more complex, new methods are necessary for effective operation and maintenance.
- Uninterrupted production.

## APPROACH

- Knowledge driven analytics customized to fit specific challenges.

## BENEFIT

### Economy

- New Business models.
- Remote operation and monitoring of multi site systems.

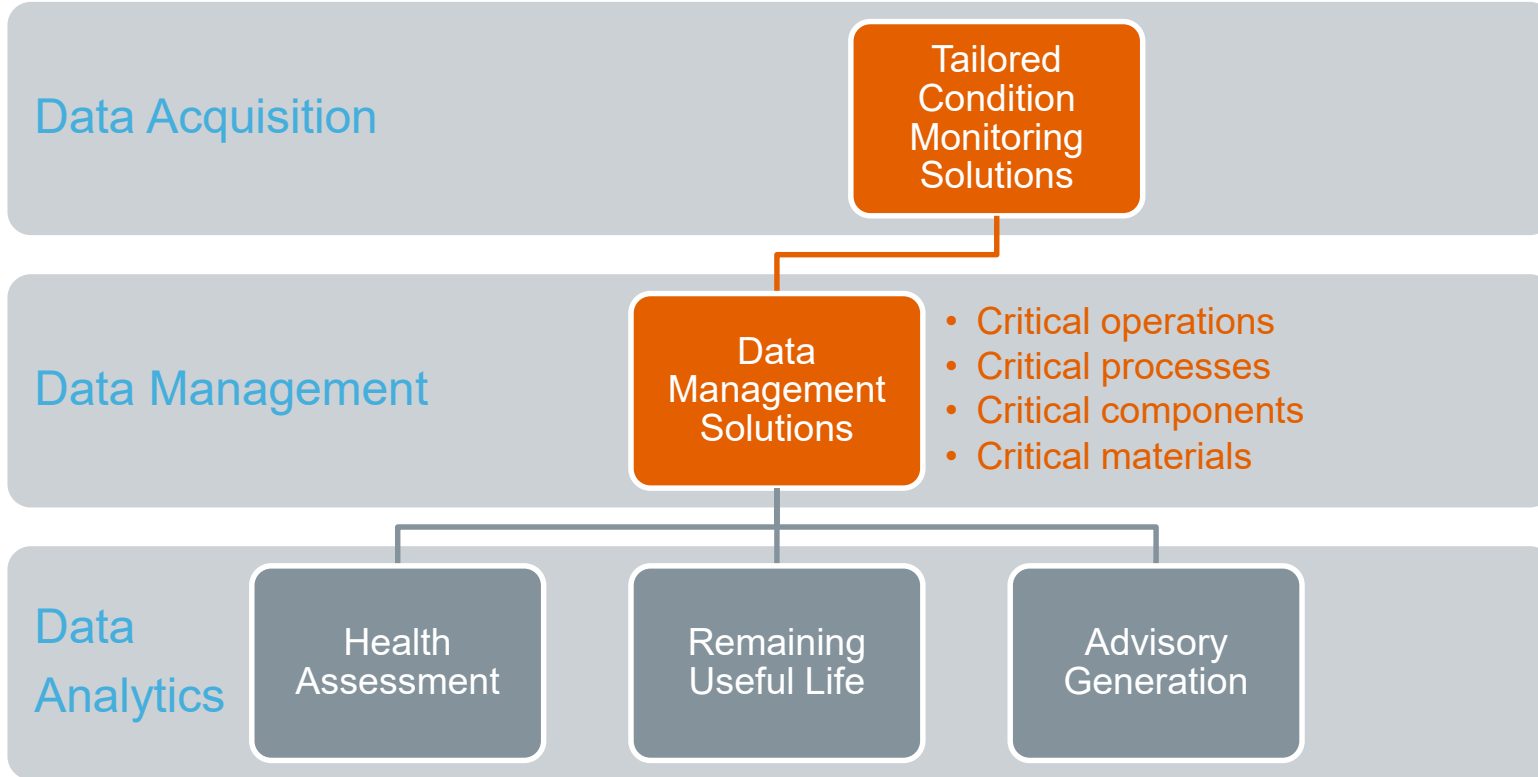
### Optimized

- Operation &
- Maintenance.

### Increased

- Performance
- Availability
- Quality
- Reliability
- Safety

# Data Acquisition, Management and Analytics



# The Goal and Impact for VTT

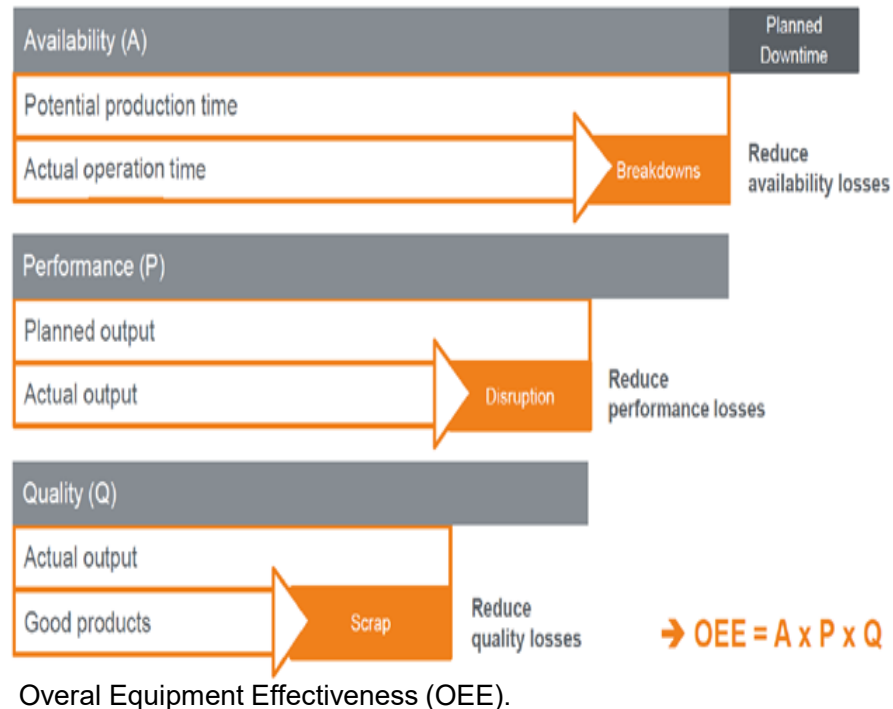
- Develop **completely automatic condition based system** that **increases OEE**
- In addition enables **enormous savings in maintenance costs**

*With Using:*

- Low-cost and automatic connecting sensors
- Automatic **self-developed** diagnostics and prognostics based to the ISO-13374-1 and 2
- The **competition is based on** comparison of **OEE**

*Next Steps:*

- **Autonomous CBM**



# Light Remote Solutions for O&M

The goal is to provide easily exploitable methods and technologies related to operation and maintenance that can be implemented for lightweight and cost-effective solutions for a range of services to implement. For Example:

- Fault and usage history of the equipments
  - Gear and bearing faults and fault history of the components
- Safety tracking
  - Load situation and other wanted alarms concerning safety



Ohjaus-, käyttö-, tila- ja kuntoanalyysit sekä -palvelut



*Taylorred sensing*



*Local analysis*



*Communication*



*Liityntä ulkopuolisiin datapalveluihin*

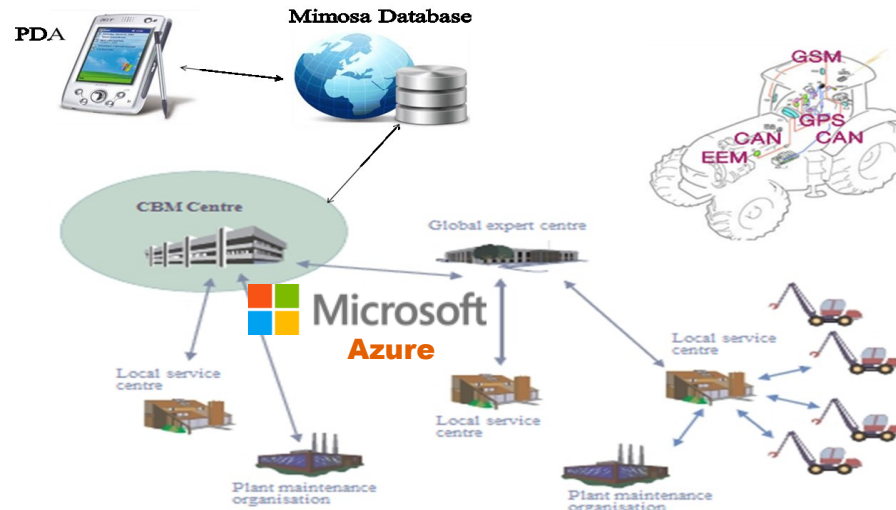
Konetaso

Käyttäjätaso

Ympäristö

# Heavy Remote Solutions for CBM

- Global Asset Management (GAM): Highlights
- The selected Internet-of-Things (IoT) platform for GAM platform development
  - Microsoft Azure Intelligent Systems Service
  - IoT framework consisting of MS products & services
- Condition Based Maintenance (CBM) Phase 1, Demo:
  - Example of E-maintenance Network and Modern Integrated Control System in Mobile Machinery



# We can bring together a large variety of competences according to the case at hand

- Extreme conditions
- Material performance & mechanical degradation
- Material modelling
- Risk management
- Wear and corrosion respective preventive methods
- Failure mechanisms
- Fuels and burning
- Wide variety of applications
- Process optimization
- Data-analytics
- and many more...







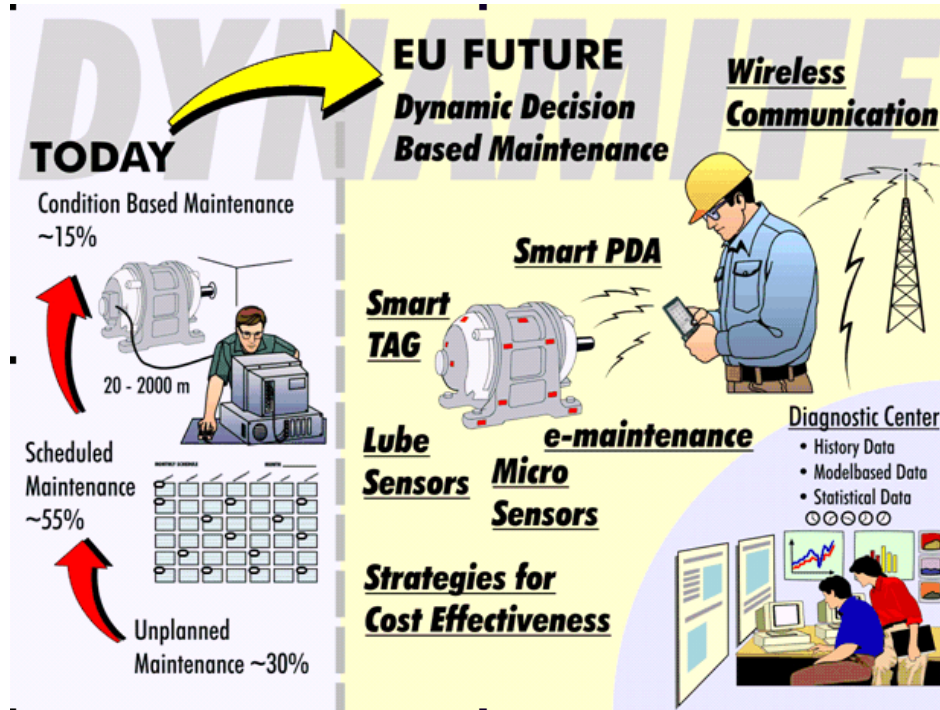
***Is your plant lifecycle fully optimised?***

***Does your current data analytics provide comprehensive support for decision making?***

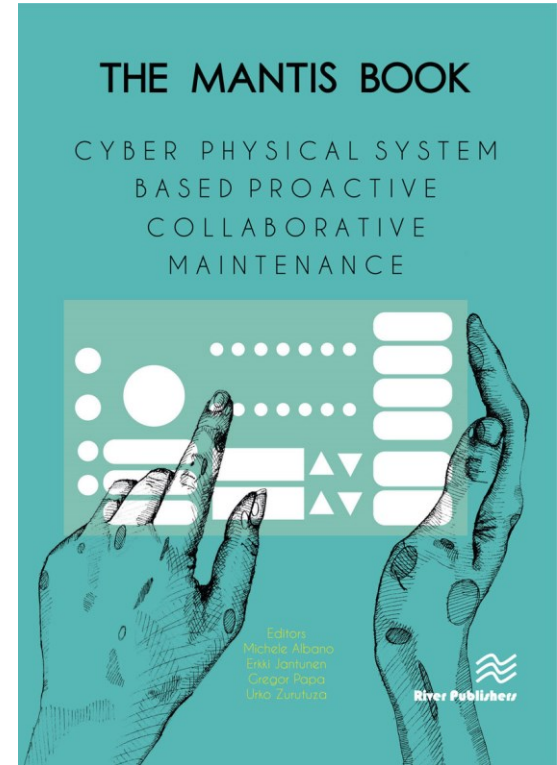
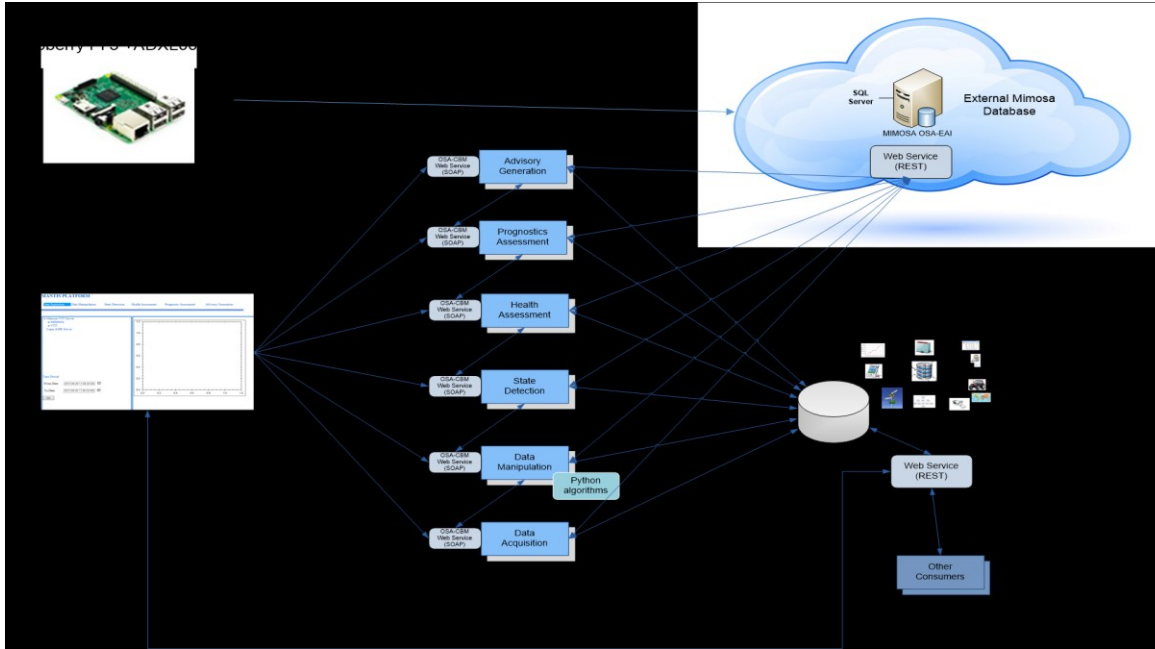
***Could you improve productivity through more advanced maintenance practices?***

# First touch with MIMOSA in 2005

Deploying MIMOSA ever since

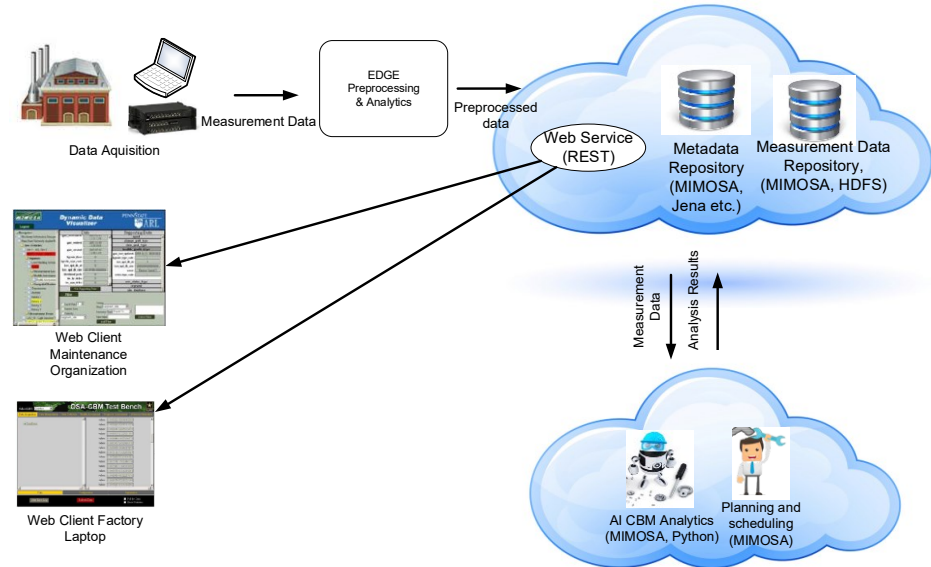


# MIMOSA OSA-CBM and Raspberry PI3



# The overall SERENA system architecture:

EDGE device Raspberry Pi3 with MEMS sensor



# Technical approach

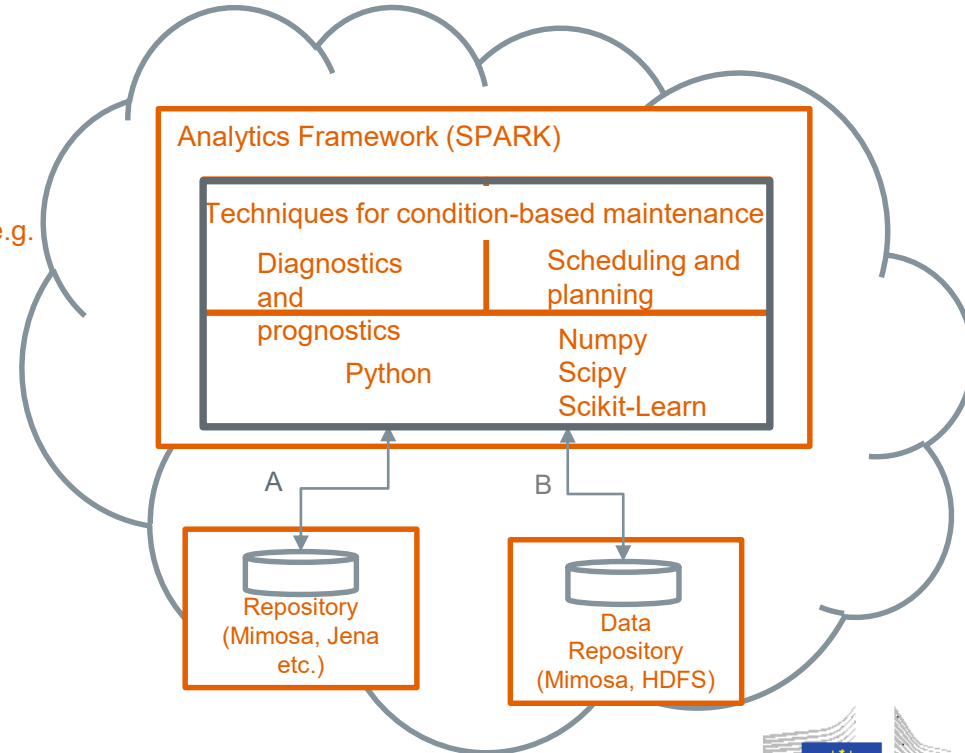
Communication between analytics module and data repositories:

Information from metadata repository (arrow A) consist of e.g.

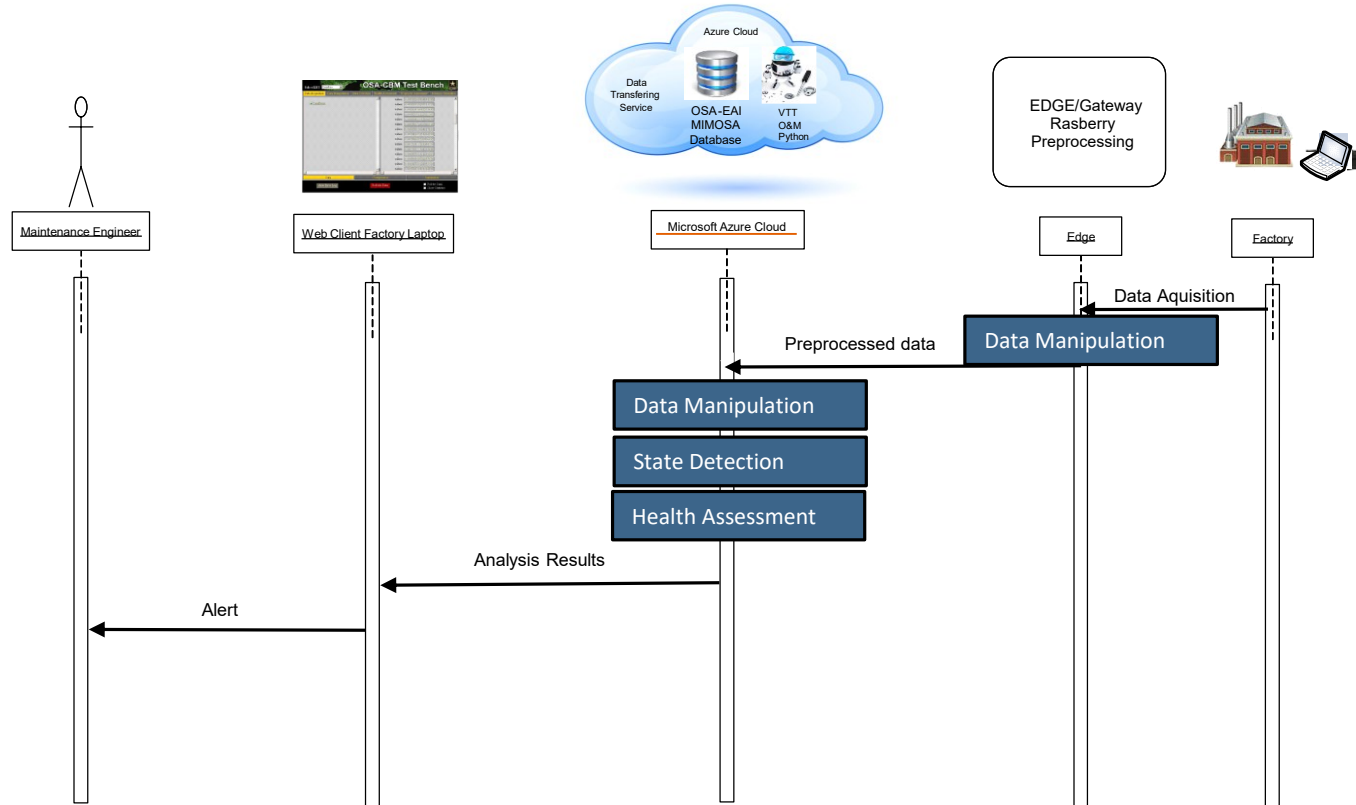
- Measurement names, explanation information, units
- Analysis configuration data
- Analytics results

Information from measurement data repository (arrow B) consist of e.g.

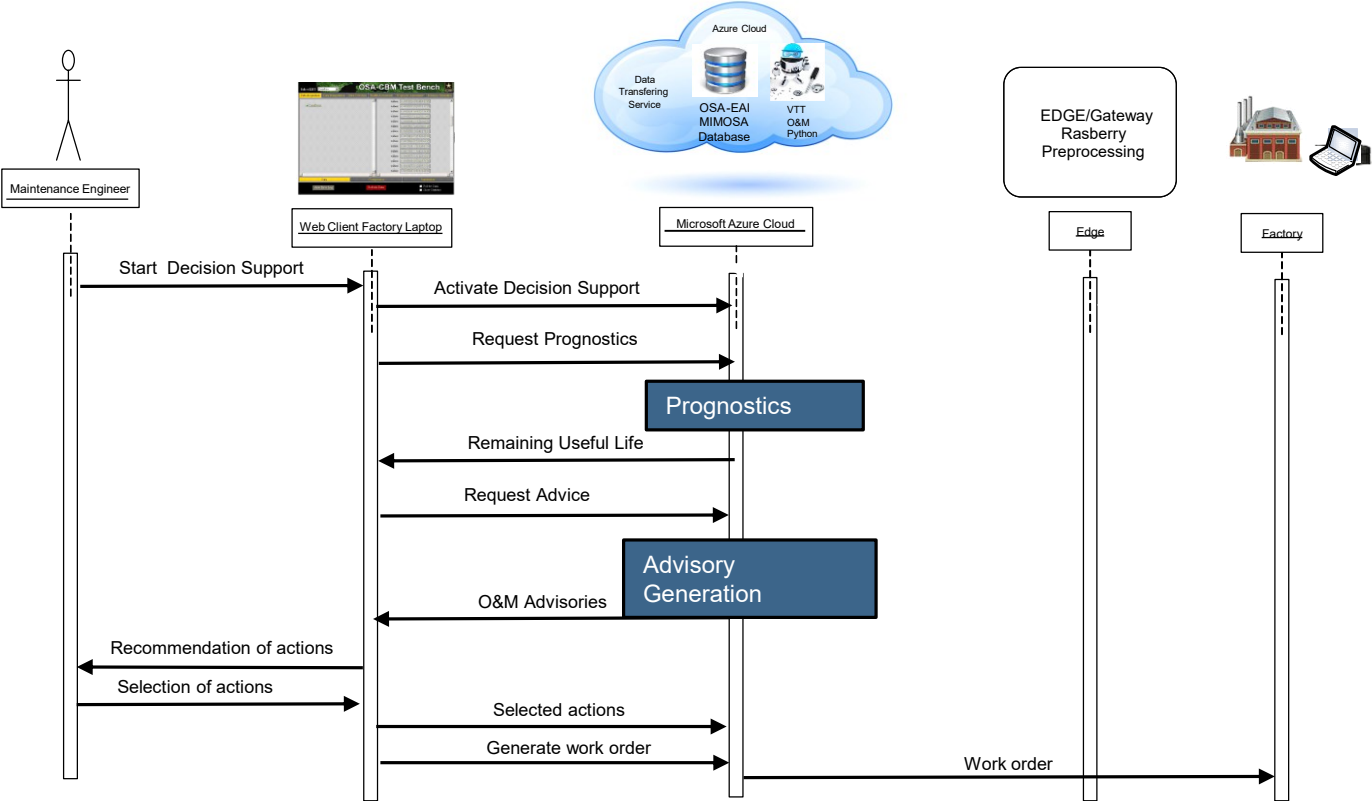
- Vibration acceleration data
- Acoustic emission data
- Sound measurements



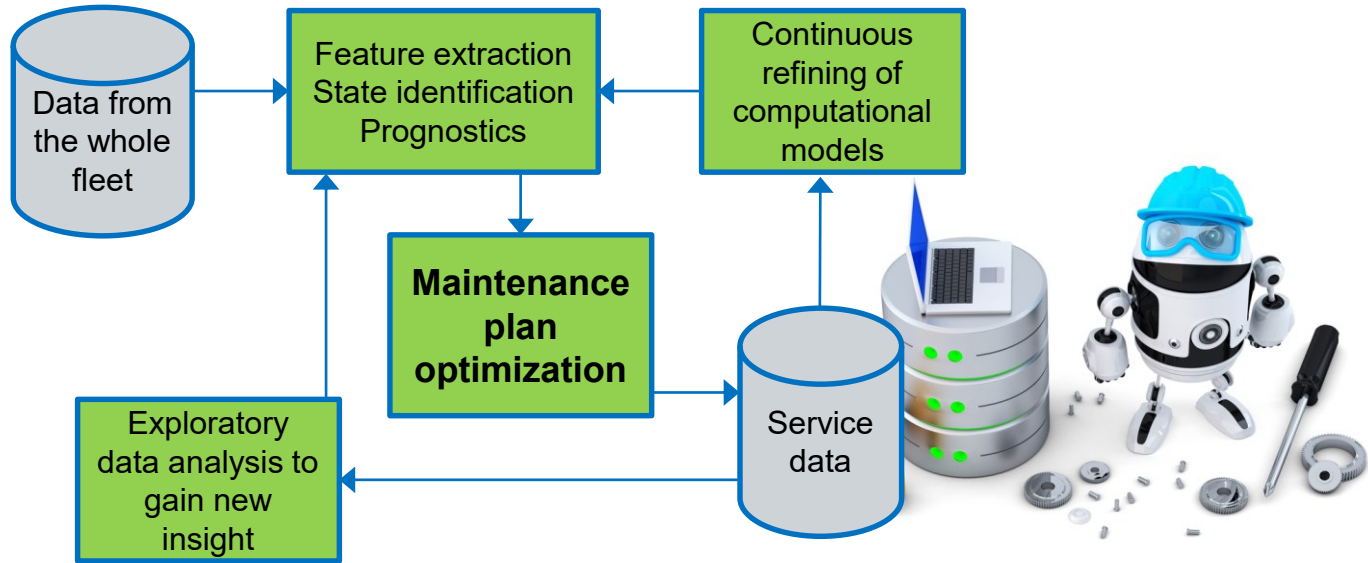
# Serena WP3 – Use Case Automatic Diagnostics



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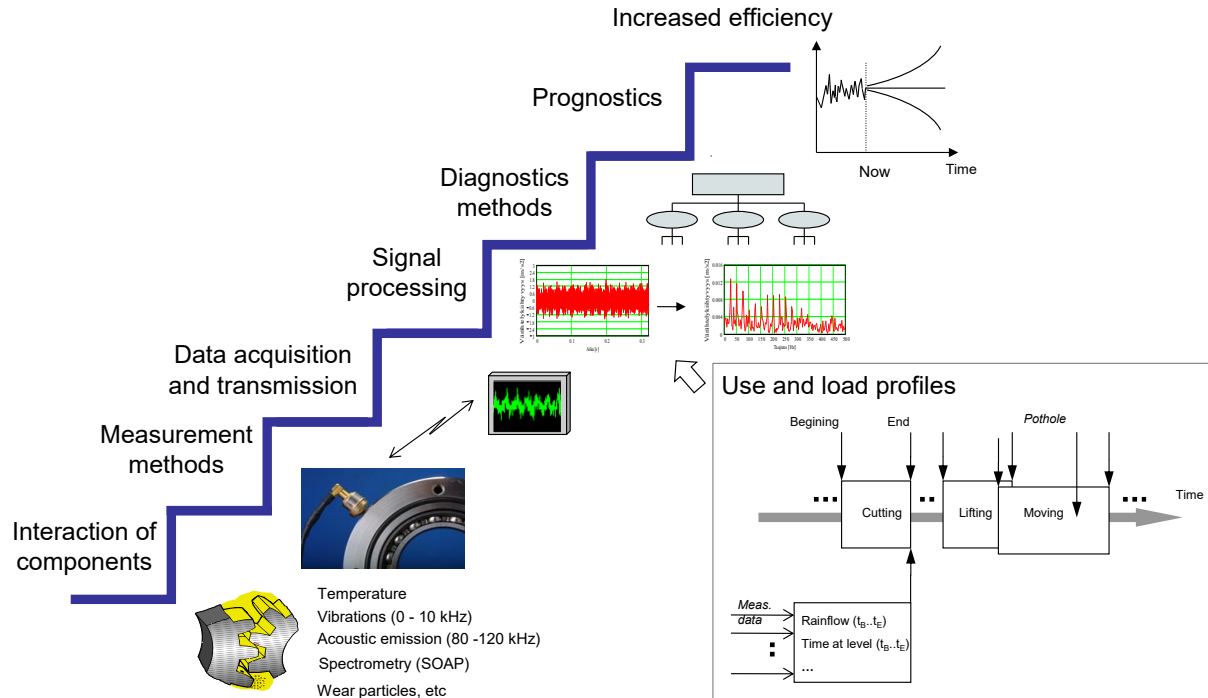


# VTT Python O&M Analytics toolbox: Continuous improvement





# Decades of background and knowledge from VTT O&M Analytics



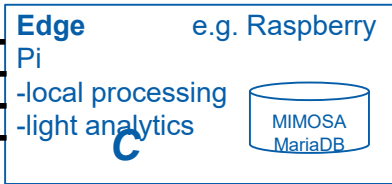
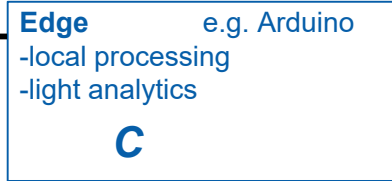
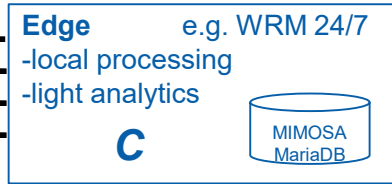
- Data import
- Data preparation
- Feature extraction
- State recognition
- Load profiles
- Anomaly detection
- Analysis of causality
- Time-frequency analysis
- Analysis of bearings and gearboxes
- Decision support

# Arrowhead Framework and MIMOSA OSA-EAI

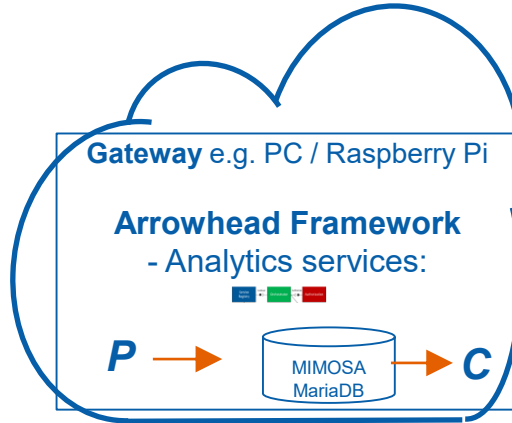
Production sites



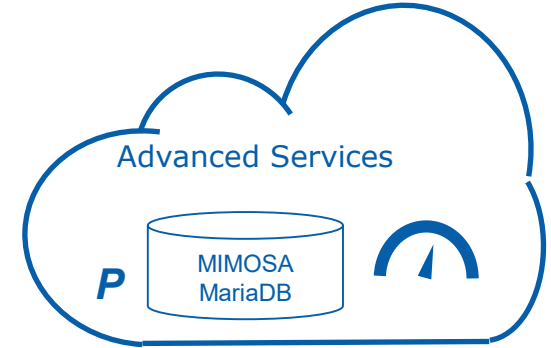
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Local Cloud



Cloud



***P** is Arrowhead service provider  
**C** is Arrowhead service consumer*

Productive4.0

# bey<sup>0</sup>nd

## the obvious

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