Co-funded by the Horizon 2020 programme
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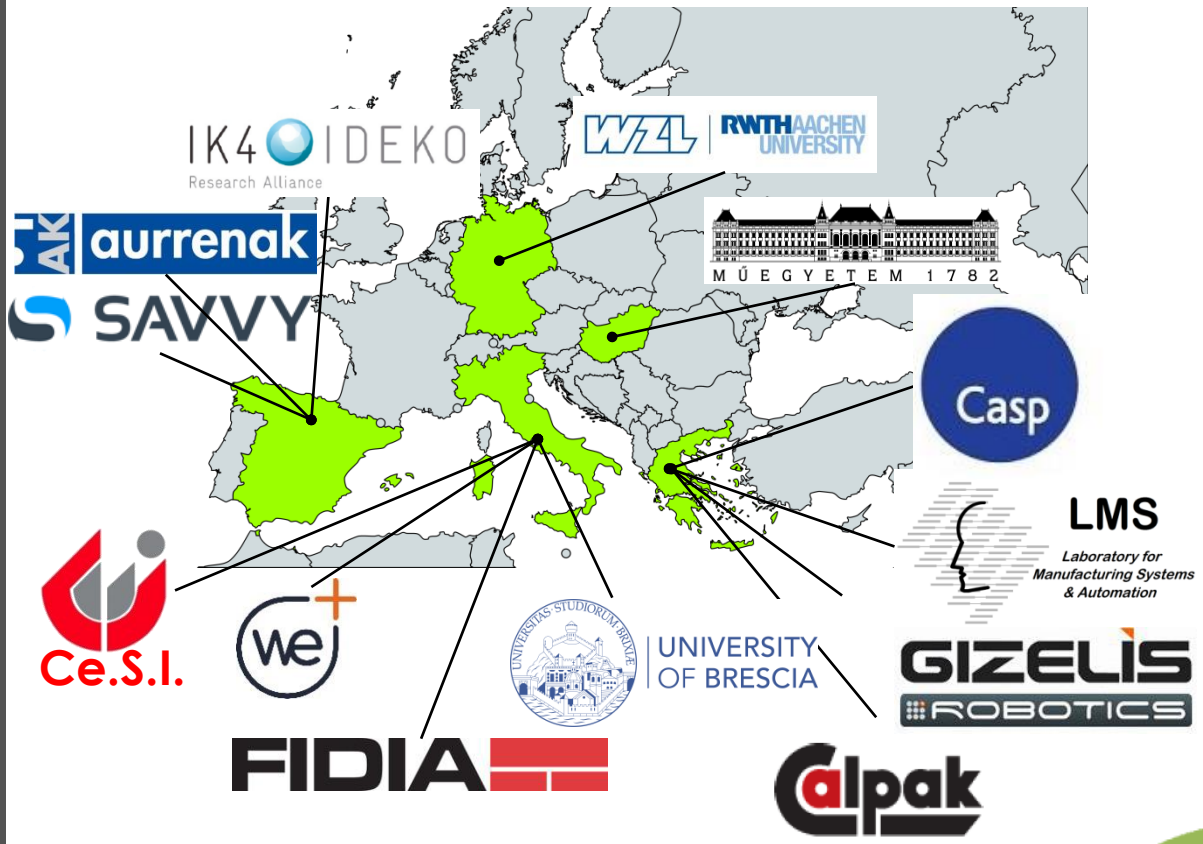
PROGRAMS

PROGnostics based **R**eliability **A**nalysis for **M**aintenance **S**cheduling

PROGRAMS project

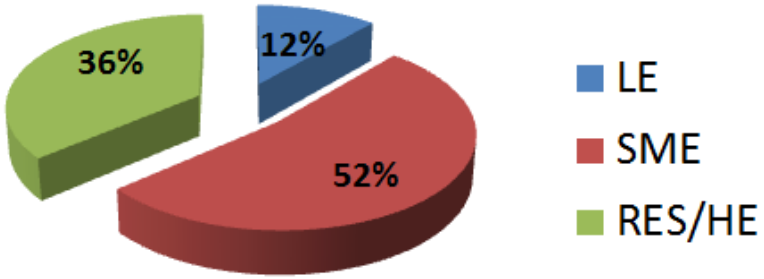
- Coordinator: FIDIA S.p.A.
- Acronym: PROGRAMS
- GA Number: 767287
- Call: H2020-FOF-2017
- Type of Action: IA
- Duration: 36 months
- Start Date: 01 Oct 2017
- End Date: 30 Sept 2020
- https://www.programs-project.eu/

PROGRAMS consortium

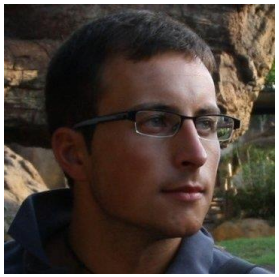


The 13 partners, coming from 5 different EU Countries reflect the spread, dimension and structure of the European manufacturing industry.

SMEs represent more than half of the partners, UNIs another third.



Coordination



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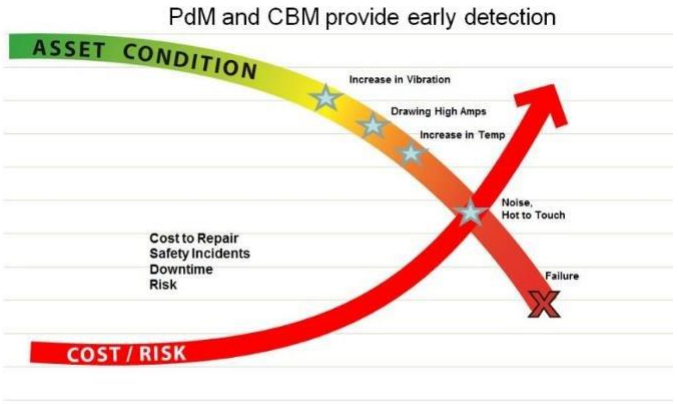
Cluster call

FOF-09-2017: Novel design and predictive maintenance technologies for increased operating life of production systems

- **Scope:** The aim would be to design **optimal maintainability solutions into production systems** to improve operating life at maximised performance and reduce costs by **carrying out maintenance activities at the most optimised time** before failure occurs, thus minimising the degree of intervention required and maximising the system availability.

Is PdM what EU customers really need?

Some industry experts believe that the field of predictive maintenance is not growing to its full potential. According to one 2014 article on condition based maintenance, "the market of CBM sales has been relatively flat for the past 5 years".



PdM and CBM strategies reduce cost and mitigate risk

The article indicates that condition based maintenance is subject to routine cost cutting actions which typically affect other more mundane items.

PROGRAMS assumption

EU customers will use PdM only if it allows them to **save their money**. PROGRAMS assumption is that PdM **by itself** is not enough to grant this result.

For this reason the PROGRAMS consortium aims at integrating PdM into a wider ICT platform capable of:

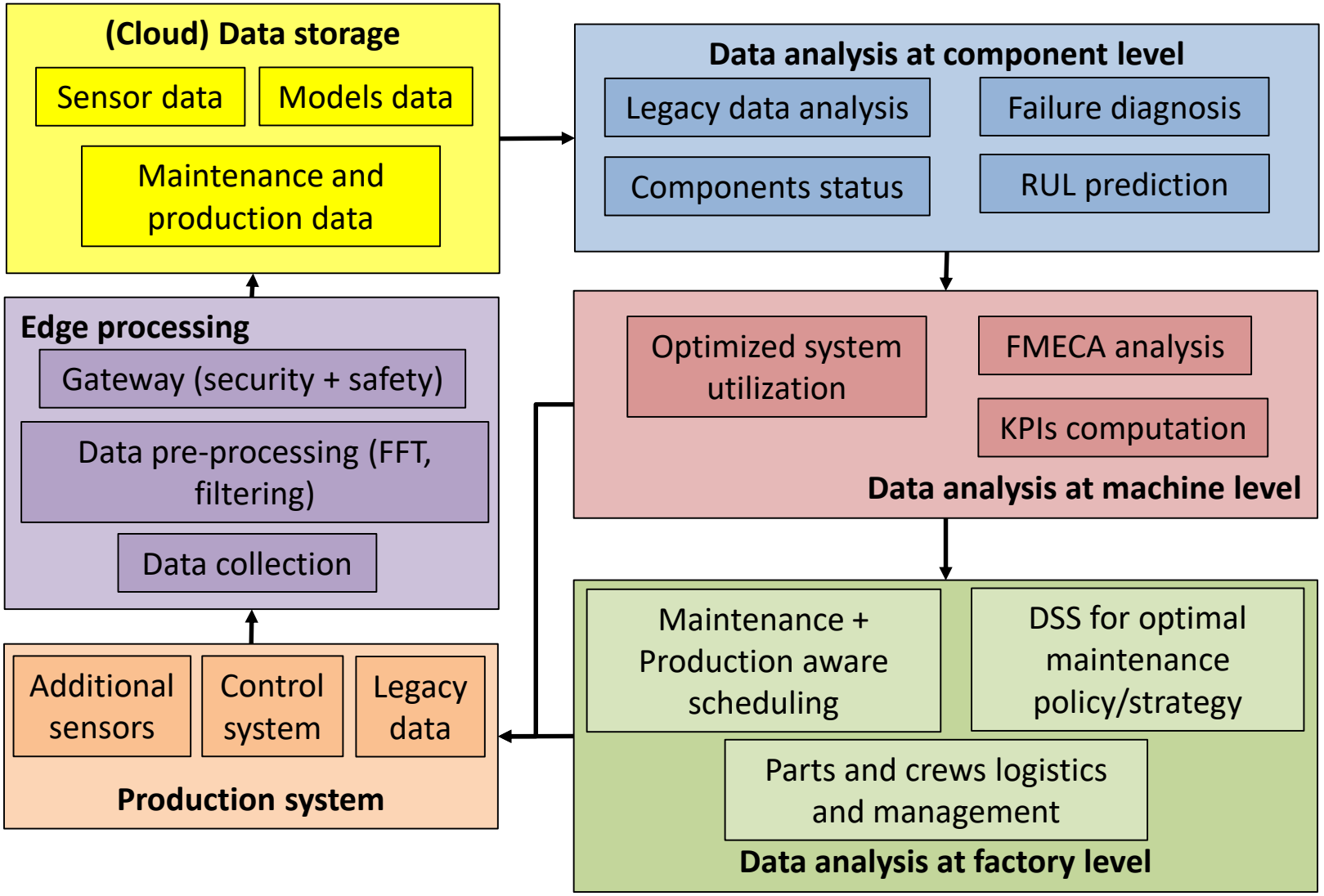
- Determining when PdM application is profitable
- Providing alternative PdM methodologies or alternatives to PdM
- Allowing PdM solutions deployment and exploitation
- Optimizing integration of PdM based maintenance with production
- Gathering and sharing all maintenance information at all factory levels

PROGRAMS solutions

The main SW **solutions** developed by PROGRAMS project are:

- an easy to install tool (Smart Control System) to collect process data and exploit them at machine level;
- a model-based prognostics method (RULE) for the smart prediction of equipment conditions;
- a novel integrated maintenance optimization system (MDSS);
- a production scheduling integrator (SST) with ERP interfaces;
- a support tool to speed up the FMECA deployment;
- an MSP (Maintenance Service Platform) tool to share maintenance information between involved personnel.

PROGRAMS conceptual data flow

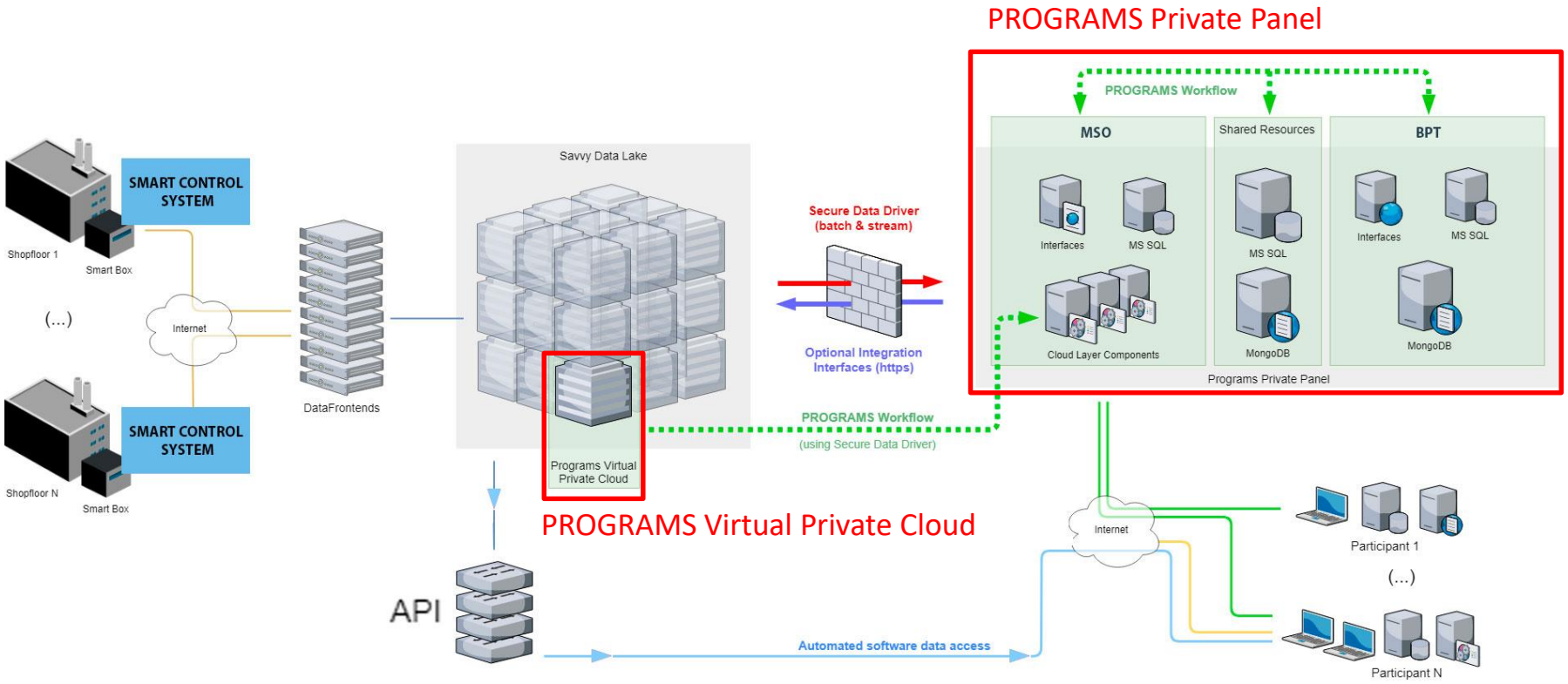


Smart Control System

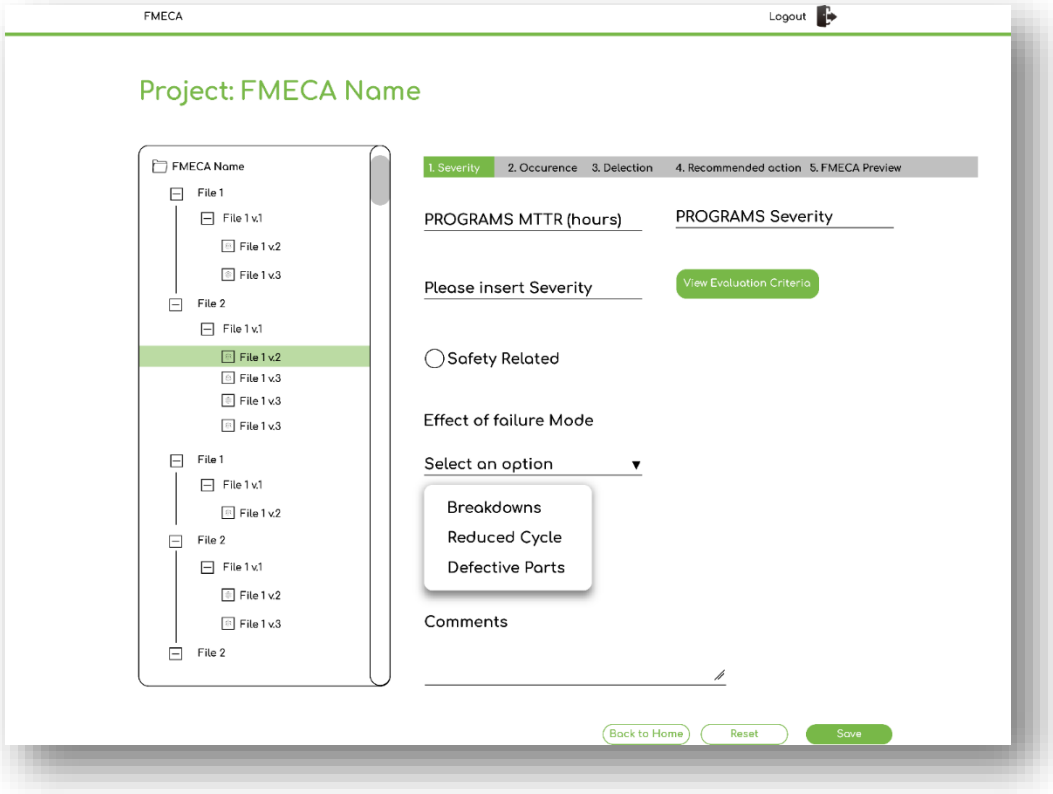
The Smart Control System includes:

- **Programmable Controller:** a programmable hardware system with processing capacity
- **Sensors Terminal Block:** inputs/outputs board to gather and process data from the sensors
- **Savvy Smart Box**: An Industrial PC for advanced computation and data managing functions
- An ethernet hub to connect to the local controllers and internet (data transfer to PROGRAMS DB).

ICT platform architecture design



FMECA support tool



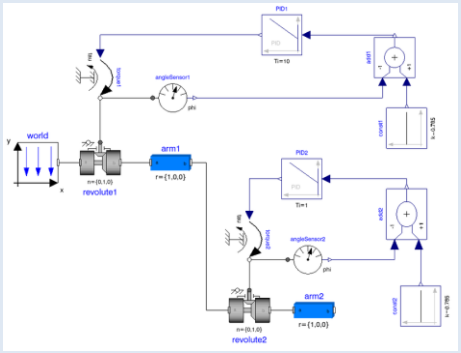
Drives the user through all the steps necessary to complete the analysis by step by step interactive “tutorial” for each phase with easy predefined options.

Methodology for advanced physical modelling

1st Phase

Modeling of **Dynamic Behavior** of the machine based on:

- ➢ Kinematic model
- ➢ Structural model

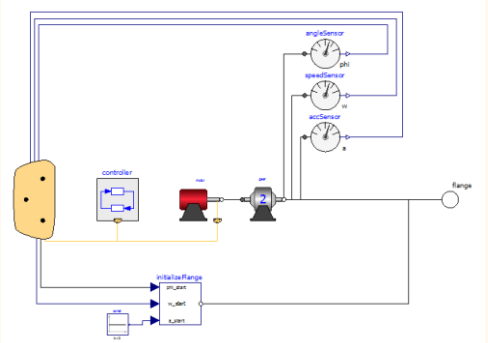


2nd Phase

Modeling of **Virtual Sensors** to:

- ➢ Monitor
- ➢ Gather

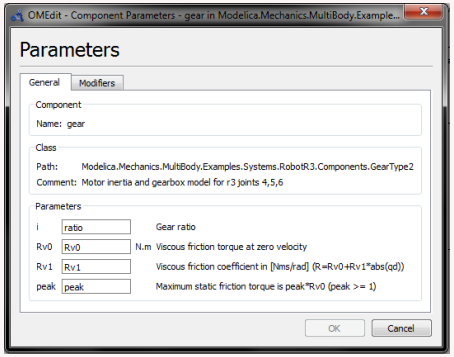
data during the simulation.



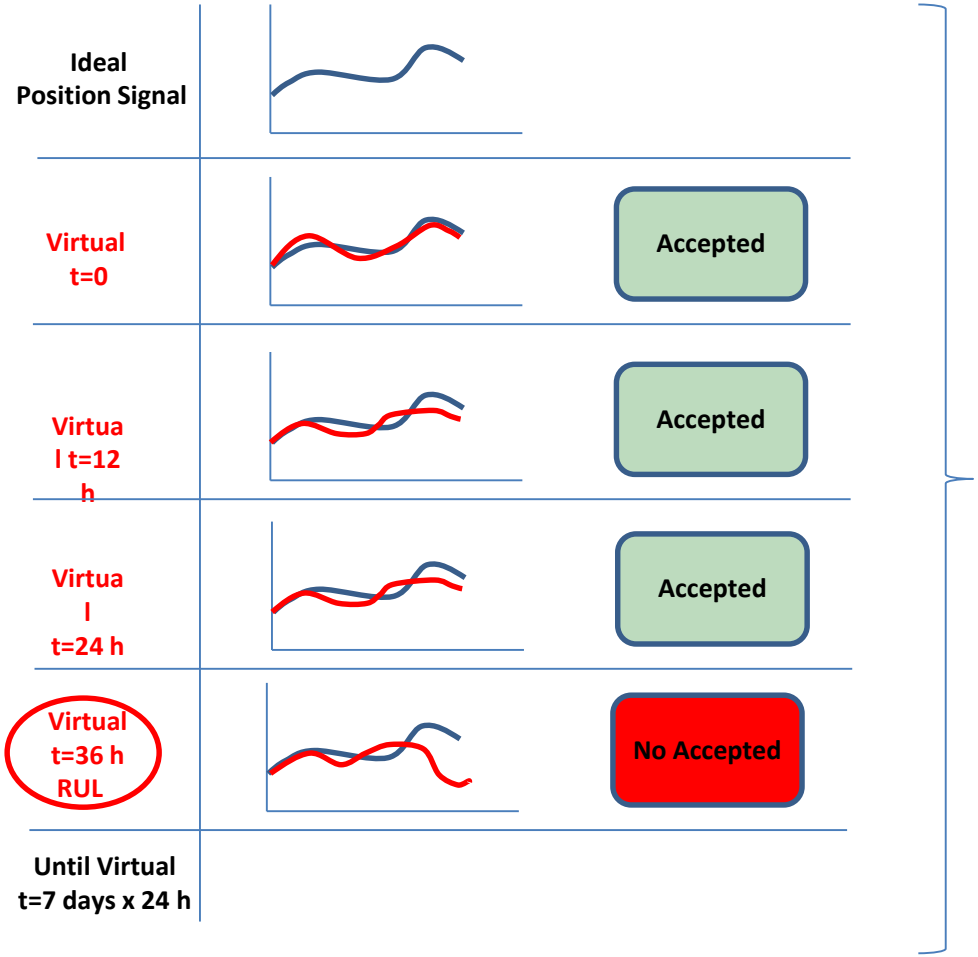
3rd Phase

Definition of the **Modelling Parameters** to:

- ➢ Update them using real gathered data.



RUL Estimation



Performance degradation patterns for critical components are based on:

- Physics based literature models
- Data driven models trained with test benches data.

Alternatively analytical estimations based on real components usage time is provided.

Maintenance Decision Support System

Maintenance Strategies

- Corrective (run to failure)
- Preventive with replacement
- Predictive (CBM)

Maintenance Policies

- Internal Crew
- External service (on-demand)
- External service (contract)
- Mix of the above

The maintenance optimization algorithm uses as objectives:

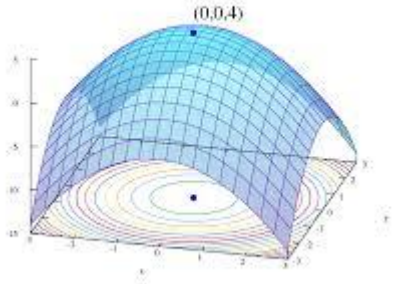
- Maximization of Availability
- LCC function minimization

leading into a multi-criteria objective function that will be used for search and optimisation.

Maintenance Decision Support System

Optimisation algorithms:

- mathematical (gradient-based)
- AI based search and optimisation algorithms



Objective functions calculation methods:

- analytical calculations → fast steady state (long term) calculations
- simulation based calculations → accurate discrete event simulations using Monte Carlo method

The MDSS system works on three levels:

- component level, machine level, and system level.

Smart Scheduling Tool

- Data retrieval (from MDSS, RULE and SCS) and fusion to create maintenance tasks taking into account:
  - Residual working time of the equipment
  - Usage time of the equipment
  - Planned workload of the equipment
- Production Maintenance tasks importing (though ERP interface)
- Fine (recursive) tuning of the maintenance tasks schedule

Maintenance Service Platform

- Share important information between employees (company/group news, company/employee posts, etc.)
- Facilitate communication with/between workers/management (upstream, downstream, transversal)
- Easier request for unplanned or reschedule of maintenance activities
- Share best practices and lessons learnt at all levels
- Improved operational practices through suggestions arriving from the workers

PROGRAMS end users

AURRENAK business focuses on the design and manufacture of moulds and tooling for the mass production casting industry, both in iron and aluminium, specialising in pressure injection, low pressure, gravity and green sand casting technologies. Its major customers are vehicle manufacturers and the suppliers of mass produced iron and aluminium parts for these manufacturers.

PROGRAMS end users

CALPAK covers all parts of solar thermal energy systems, producing a complete range of solar collectors, hot storage tanks, complete central solar systems and thermosiphonic systems. Its selling points are both the residential market as well as the industrial market.

PROGRAMS end users approach

Currently AURRENAK and CALPAK perform their maintenance tasks based on the parameters of the equipment/component declared by their manufacturers, following generally the baseline of preventive maintenance, and maintenance tasks take place following the instructions of the equipment manufacturers.

Additionally, when the equipment‘s behaviour is out of the nominal boundaries, the monitoring of the components takes place manually (operator inspection).

Typical failures:

- gear, spindle, pinion and rack, motors and other mechanical components’ breakdown

PROGRAMS end users expectations

Expected benefits:

- better equipment exploitation by reducing downtime;
- reduced maintenance costs by avoiding costly machine breakdowns;
- reduced rework and quality related costs by continuously monitoring equipment conditions;
- increased in competitiveness due to a decrease in products manufacturing operating costs;
- increased in sales resulting from the possibility of addressing markets that previously were restricted by cost issues.

A final note on integration

The data formats and the communication protocols selected and implemented in PROGRAMS :

- Allow the smooth integration of independent components into the final systems
- Are compliant to relevant EU standards

Service layer: is the set of web services exposed by a module to exchange information with GUI, other components and third party solutions.

RESTful web services + TLS 1.2 security protocol + JSON files

If resources allow, we should consider the possibility of verifying and then exploiting the possibility of integrating solutions developed by (some of) the cluster projects.

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THANK YOU!!