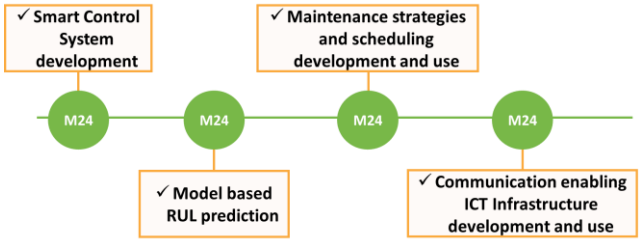
PROGRAMS preparations for the final demonstrators on board!

INTRODUCTION

The European research project **PROGRAMS** has been running since October 2017 and its activities aim at the optimal maintenance management in a manufacturing environment. To this end, **PROGRAMS** consortium has implemented a set of tools that allows the maximization of the operating life of production systems and the minimization of maintenance related life cycle costs.

By the 30 months of the project's activity, all the workpackages related to technical developments have been completed, the validation activities in laboratory are almost complete, and the consortium is in the process of setting up **PROGRAMS** demonstrators. In particular, all the foreseen **milestones** of **PROGRAMS** have been achieved in time:



Latest milestones achieved

PROJECT ACTIVITIES

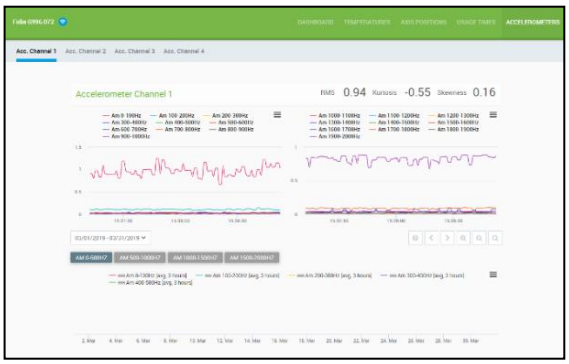
PROGRAMS pilot cases are provided by two SMEs: **AURRENAK,** which focuses on milling, and **CALPAK,** which focuses on robot assisted welding. The consortium developed a maintenance platform that seamlessly implements the following tools:

- Equipment Control Module (ECM): enables equipment field data collection, storage and exploitation.
- Maintenance Service Platform (MSP): for maintenance information collection and sharing.
- Maintenance Schedule Optimization (MSO): a decision support system for strategies and policies selection.
- Behaviour Predicting Tool (BPT): provides online predictions of RUL for all the modelled components of the pilot cases, together with an end-of-life probability.
- Failure Mode, Effects, and Criticality Analysis tool (FMECA): assisted procedure for FMECA performance.
- Smart Scheduling Tool (SST): for scheduling optimized maintenance and production activities.
- Advanced System Invariant Analysis (ASIA): allows a data driven real-time diagnosis of machine states.
- Quick RUL: for rapid RUL estimation when machine-learning and data analytics algorithms are not available or trained yet.

More details about the latest improvements and activities relative to the implemented modules are provided in the following sections.

▪ ECM

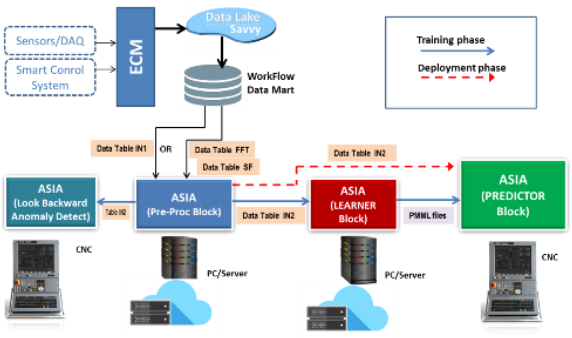
The ECM (that allows the collection of signals from factory level sensors and equipment controllers) has been deployed on both use case scenarios. Now customized dashboards allow plant managers and operators to monitor the equipment from remote.



Data capturing from the AURRENAK machine

▪ ASIA

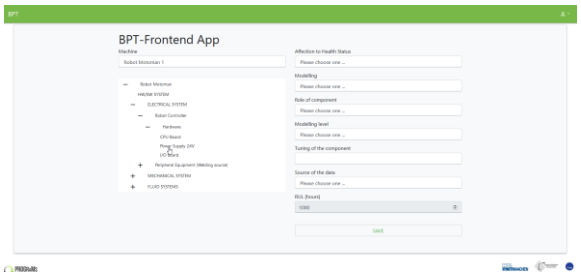
ASIA has been developed to perform a real-time local evolving diagnosis of machine states (Normal, Starting anomaly, Warning, Failure incipient). In this way, machine operators/maintenance managers can decide to activate some checking/inspection procedures. The ASIA tool training is almost complete and preliminary status estimation is already available.



ASIA workflow

- **BPT**

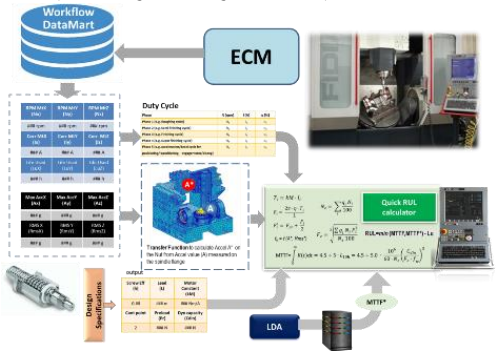
BPT development has been completed by integrating the outcomes of previous activities, i.e. assets' modelling, RUL estimation algorithms implementation, etc. The module now includes a set of web-services enabling easy access to its functionalities and a graphical user interface to present analytics information about the status of each machine, while simultaneously allowing the users to gain insight to specific parameters according to their interest.



BPT GUI

- **Quick RUL**

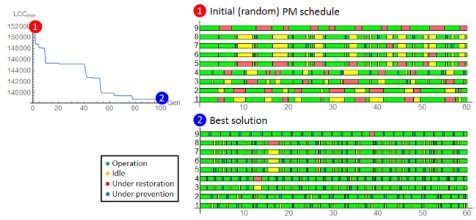
This estimation method/module relies on the physics-based models of MTTF that are fed by some relevant monitored process signals/parameters and design data. Quick RUL estimation is an alternative (approximated) method to exploit when machine-learning and data analytics algorithms are not available (or not yet fully trained).



QuickRUL workflow

- **MSO**

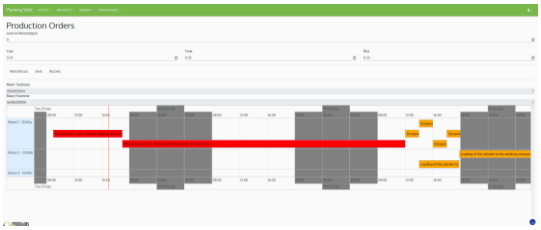
A methodology for maintenance schedule optimization has been developed, addressing the selection of the most cost-effective maintenance strategies and policies as well the possibility to find those maintenance schedule intervals which minimizes the cost or maximizes the availability. The maintenance strategies include Corrective Maintenance, Preventive Maintenance and Predictive Maintenance. A novel hybrid approach using analytical and Monte Carlo simulation-based calculations and an AI-based search method (genetic algorithm), including maintenance action clustering, have been employed.



MSO genetic algorithm

- **SST**

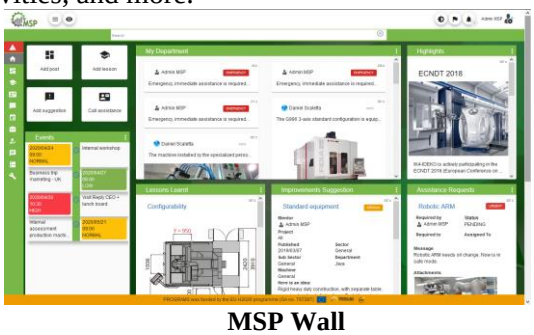
SST has been implemented for the optimization of the integrated production and maintenance activities scheduling. SST can now retrieve production plans from a wide range of commercial ERPs thanks to its open interface based on REST services.



SST GUI

- **MSP**

The development of the MSP tool aims at facilitating the communication with and between the workers in a company/factory/shop floor. The MSP is based on the social network paradigm, where the users can freely connect, communicate and share information in a personal way. At the same time, the tool facilitates the exchange of maintenance related information and sends notifications about the conditions of the production machines, current and planned maintenance activities, comments related to current production situations, problems related to production activities, and more.

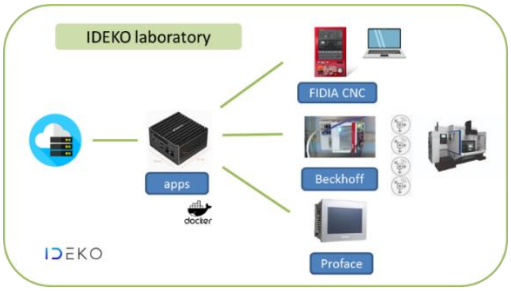


MSP Wall

PROGRAMS MODULES VALIDATION

The objective of the validation activities (performed during the last 9 months) was the testing of the Smart Control System and Central Cloud Applications

functionalities in a safe environment before moving on to the real demonstrators. Furthermore, the ramp up of the integrated modules was completed as well. Testing activities were performed in a stand-alone mode as well as with an integrated approach using a set of dummy sensors. The main laboratory demo was set up at the IDEKO facilities. The following figure describes the HW composition of the laboratory demo, where the SW modules and local functionalities have been deployed for testing.



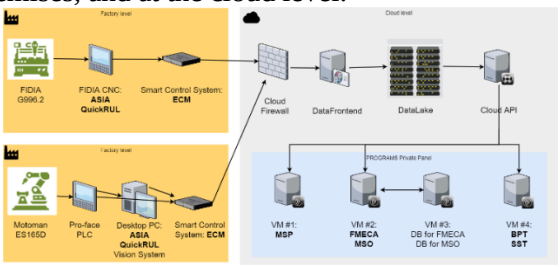
Laboratory demo 1

- FIDIA C20 numerical control: a FIDIA controller simulator for testing purposes.
- Beckhoff CX5130-0155 acquisition board: a Beckhoff device with the Twincat TC3 Condition Monitoring library
- Pro-face PFXSP5400WAD controller + HMI: a hybrid controller and HMI device connected (at CALPAK) to the Motoman DX100 controller.
- Savvy Smart Box: an industrial PC that acquires the data and acts as a gateway to the cloud-based persistence layer.

Laboratory validation will be closed by M33.

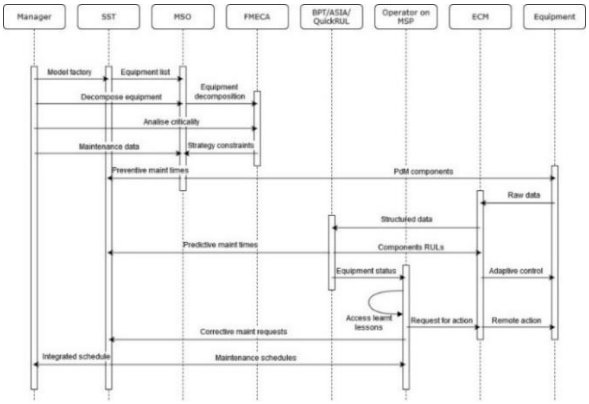
PROGRAMS MODULES DEPLOYMENT

SAVVY provided the cloud infrastructure and resources for project participants to deploy the applications and modules of the PROGRAMS set of solutions. The diagram below illustrates the current architecture for the complete PROGRAMS solution, both at the factory (local) level at each End User's premises, and at the cloud level.



PROGRAMS modules deployment

The consortium designed the demonstration scenarios that will allow to evaluate the performance of all the functionalities implemented in the PROGRAMS solutions. The scenarios converge into a seamless data flow that links operators on the field, operators on the management, PROGRAMS modules and equipment.



Scenarios data flow

PROGRAMS consortium will now focus on the setup and deployment of the final demonstrators which will be showcased by the end of the project.

PROGRAMS LINKS

- **PROGRAMS Web Portal**
  https://www.programs-project.eu/
- **PROGRAMS Twitter**
  https://twitter.com/programsEU.
- **PROGRAMS Youtube**
  https://www.youtube.com/channel/UCCmwwxFAX7LzfrwKFAZQv9w .

PROGRAMS CONSORTIUM

Contact:
Project Coordinator: FIDIA
Contact person: Michele Surico
Telephone: +39 335 6609984
Mail: m.surico@fidia.it