ITEA 4

Project Results

DayTiMe

Digital twins to enhance predictive maintenance

By determining the condition of in-service equipment, predictive maintenance (PdM) allows problems to be fixed before they occur. The ITEA project DayTiMe (Digital Lifecycle Twins for Predictive Maintenance) has used digital twinning to extend this into various domains.

Project origins

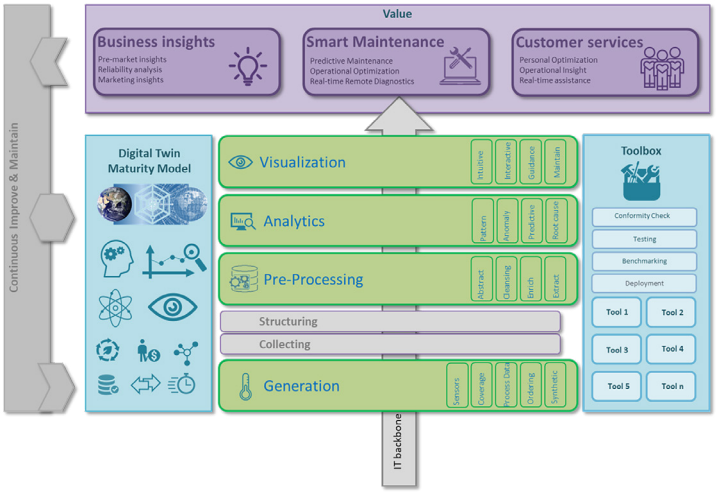
PdM has clear benefits in terms of time, effort, costs and safer conditions. However, two challenges emerge when combining PdM with IoT: obtaining high-quality labelled data from industrial machines and applying automated PdM techniques to provide actionable, condition-based maintenance information. The solution lies in digital twins, which can turn masses of raw sensor data into real-time monitoring for systems and processes.

DayTiMe has taken digital twins beyond the traditional realm of manufacturing by applying AI, big data analysis and machine learning for PdM in domains such as healthcare and telecoms. The starting point was the definition of five use-cases: MRI scanners, shavers, medical supply systems, fault detection in industrial data and GSM base stations. Commonalities were then uncovered and incorporated into a generic reference architecture. Within these use-cases, 14 demonstrators prove the feasibility of combining PdM with digital twinning.

Technology applied

In creating the reference architecture, DayTiMe focused on extending the State-of-the-Art in each use-case and mapping them to generic layers for data generation, pre-processing, analytics and visualisation, all supported by an IT backbone. Third parties can utilise APIs to run their own applications on the generic software, allowing them to develop their own business insights, smart maintenance and/or customer services.

To enable PdM, the architecture includes a digital twin maturity model which creates digital twins of each connected device to allow for offline optimisation through data analysis of its real-time condition. Additionally, a toolbox with various tools for conformity checks, testing, benchmarking and deployment allows software engineers to easily adapt their software according to the architecture basis. This also contains building blocks for tool infrastructure and identifies standardisation needs and opportunities.



DayTiMe reference architecture

Besides the architecture, DayTiMe has developed various innovations per use-case. For shavers, digital twinning allows for the personalisation of pressure and skin cutter distance and communication of this to the user via an application. For GSM base stations, a feedback loop has been constructed between an extract, transform, load (ETL) tool and a prediction tool. The fusion of station metrics and customer complaints allows for better prediction, which can be indicated on a map-based environment. Regarding MRI scanners, the project has developed knowledge extraction from human-written text, anomaly detection in huge unstructured logfiles without the need for domain knowledge and anomaly detection in sensor data which is biased by utilisation data and polluted with device interference. Finally, fault detection in industrial data has resulted in an improved AI-based algorithm for anomaly detection in high-dimensional timeseries data, the automatic discovery of delay and time constant relations between signals and the integration of improvements, including user interface elements, into the Yanomaly application for machine data analytics.

Making the difference

The primary focus of DayTiMe has been proving the technological feasibility of combining digital twinning with IoT for PdM. This has been demonstrated via the project's use-cases and the consortium members will now focus on continuous improvements to bring the technologies

from TRL 3 up to TRL 6-7 over the next few years. A solid basis has already been achieved to ensure success in this. For example, DayTiMe's PdM methods have reached 90% equally weighted accuracy in the detection of critical situations for failure prevention and 98% accuracy has been realised for efficiency in decision-making (statistical confidence when analysing sample data to derive maintenance needs).

Thanks to this foundation, the partners expect DayTiMe's results to be commercialised within one to two years of the project's completion. Additionally, most partners expect to make their return on investment within two to three years. For instance, exploitation of the project's results in existing technologies has already allowed Datenna to increase their workforce from three to 36 FTE and TAZI to grow from 15 to 36 FTE. These factors are partially enabled by strong growth in the markets which DayTiMe serves, which will create opportunities for the technology in new domains and allow early up-takers to carve out a sizeable market share in emerging fields. The global digital twin market, for instance, was worth USD 10.3 billion in 2021 and is expected to reach USD 61.5 billion by 2028 at a compound annual growth rate of 35%.

In the longer run, DayTiMe expects to make positive contributions to the use-case domains and beyond. By shifting from reactive to predictive maintenance, unplanned downtime can be significantly reduced, resulting in less maintenance costs, better service quality and a smaller environmental impact through less waste and resource usage. This will also increase the proactiveness of services, helping to increase customer satisfaction and even save lives in critical domains such as medical supply systems. In addition to publishing 42 papers, DayTiMe has made its AI toolset available as open source. As with the PdM process itself, this will generate feedback for improvement to the project's results and applications for many years to come.

Major project outcomes

Dissemination

- 42 publications
- 8 presentations at conferences/fairs

Exploitation (so far)

New products:

- New intelligent shaver (pressure sensor, customisation of shaving)
- Medical supply system (predictive maintenance on medicine dispenser cabinet for hospitals)
- Digital twins

New services:

- MRI scanners (machine learning classification tools)
- Fault detection in industrial data (reduction of unplanned downtime and maintenance cost)
- Self-learning tool for AI
- Multi-agent reinforcement tool

New systems:

- Toolbox for AI innovations
- GSM base station (maintaining connection up-time and service quality, in return, reduced customer churn rate)
- Digital medical cabinet (predictive maintenance tools)

Standardisation

- 9 contributions to standardisation bodies

Patents

- 1 patent application filed

ITEA is the Eureka R&D&I Cluster on software innovation, enabling a large international community of large industry, SMEs, start-ups, academia and customer organisations, to collaborate in funded projects that turn innovative ideas into new businesses, jobs, economic growth and benefits for society. ITEA is part of the Eureka Clusters Programme (ECP).

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DayTiMe

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Partners

Belgium

- Yazzoom

Netherlands

- Datenna BV
- Eindhoven University of Technology
- Philips Electronics Nederland BV
- Philips Consumer Lifestyle
- Philips Medical Systems Nederland BV
- PS-Tech BV
- Thunderbyte.AI
- University of Groningen

Turkey

- Havelsan
- Mangodo Dijital Pazarlama ve Reklam Cönzümerli Tic. Ltd. Sti.
- Tazi Bilisim Teknolojileri A.S.
- Triatech Tibbi Sistemler Tic. ve San. A.S.
- Turkcell Teknoloji
- V.A.S. Telekom

United Kingdom

- Centre for Factories of the Future Ltd

Project start

September 2018

Project end

March 2022

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