Data Analytics in maintenance – flexible and efficient

Targeted data analytics form the basis for optimising maintenance. Many mobility service providers, however, fail to use data analytics efficiently for their specific applications. Experience has taught us that specialist expertise, technological flexibility and the right course of action are key to successfully making the most out of existing data.

A cooperation between **Puzzle Mobility** and **ENOTRAC AG**

In industries such as mobility, where systems are linked with high investment costs and a long service life, optimising maintenance processes pays off. Timely maintenance is not just a major driver for profitable systems operation. It also ensures safe and non-stop operation with a consistent quality, thus preventing lost revenues.
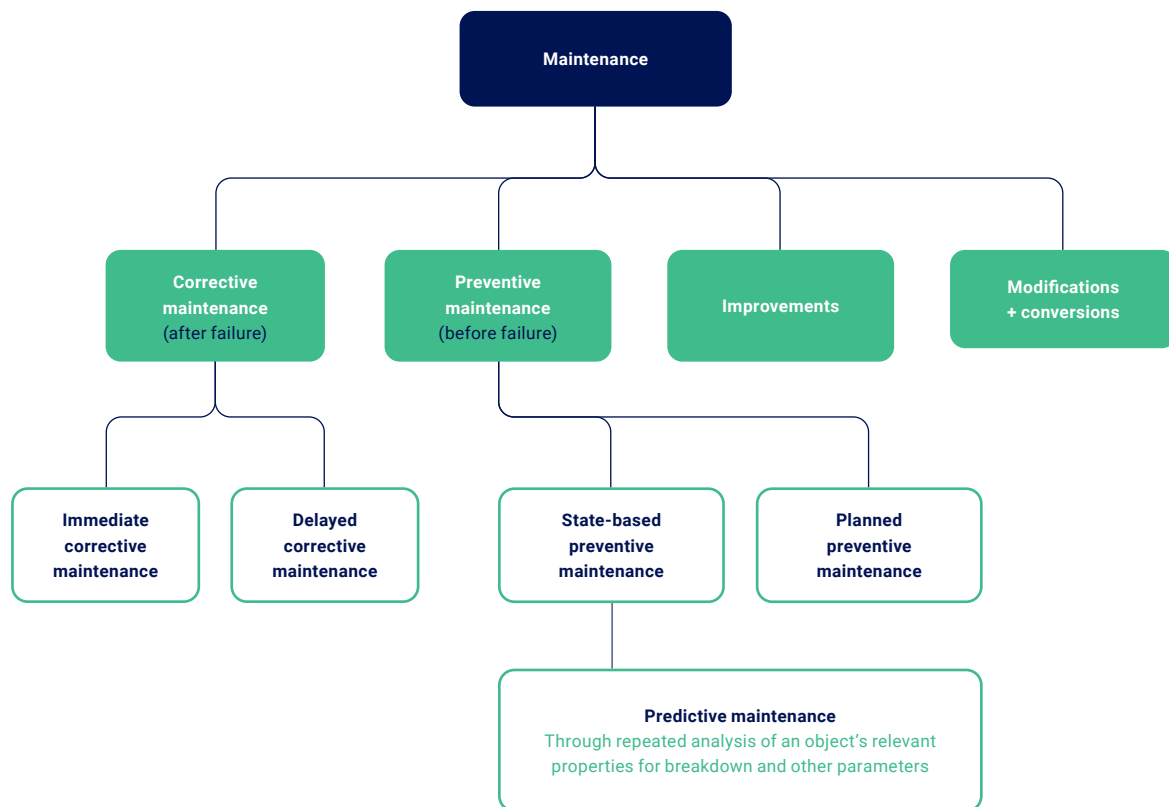
The increasing complexity of systems, due to new properties, rising networking and integration, for example, is making their maintenance ever more challenging.

This has led to the term 'predictive maintenance' becoming more significant in recent years. The main goal of predictive maintenance is to make advanced maintenance planning as precise as possible and prevent unexpected system downtimes. In the best case, maintenance measures are performed just before the potential failure of an object due to defects. The predictive maintenance method complements the other maintenance strategies shown in the following illustration.

While a time-based or usage-based maintenance strategy is relatively easy to put into practice, a state-based method is much more challenging: it requires a high-quality and – depending on the application – extensive database, which in turn requires a higher level of digitalisation.

PUZZLE MOBILITY

Maintenance strategies

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Maintenance

Corrective maintenance (after failure)

Preventive maintenance (before failure)

Improvements

Modifications + conversions

Immediate corrective maintenance

Delayed corrective maintenance

State-based preventive maintenance

Planned preventive maintenance

Predictive maintenance
Through repeated analysis of an object's relevant properties for breakdown and other parameters

Challenges in practice

The benefits of data-based maintenance are obvious, but many companies face difficulties when it comes to making data analytics projects a reality. During discussions with our mobility customers, along with proofs of concept and projects that we have been able to implement particularly with vehicle data, we constantly come up against the following challenges:

- The data needed for an application is not yet available in digital form.

- The target systems for predictive maintenance supply too little data, e.g. only once an event occurs or in an insufficient quality.

- Depending on the system, cross-manufacturer standards don't exist, e.g. with vehicle diagnostics data.

- Too much focus is placed on introducing technical infrastructure and too little on the required specialist expertise. As a result, tools without any real benefit for the technical processes are often bought.

- There is a lack of specialist expertise for the overall system in which the system under inspec-tion is embedded.

- The different maintenance types (corrective, preventive, etc.) are isolated and not viewed in combination with each other.

To ensure that our customers are able to optimise their maintenance and keep it affordable, we rely on high specialist expertise, our flexible technology kit and a proven course of action when implementing data analytics projects.

Specialist expertise is crucial

Experience has taught us that specialist expertise in the system is crucial for getting the most out of data analytics. Technical knowledge of the system under inspection, but also of the overall system, is a relevant factor here. Especially with mobile systems, where the overall system is constantly changing (due to movement, seasons, wagon order with trains, etc.), this understanding is key when interpreting data (cause-effect analyses $\rightarrow$ error pattern).

A combination of different maintenance methods based on technical expertise also plays a decisive role.

Furthermore, we have discovered that frequent, more precise technical data analyses, which we need when implementing a predictive maintenance application, are of benefit to customers: these intermediate steps in project execution give companies better databases to generate added value, even before the strategy is expanded to include predictive maintenance.

Data analytics kit

Based on these findings, Puzzle Mobility and ENOTRAC took an iterative approach in creating a flexible kit to enable the gradual development of specialist applications in state-based maintenance.

Based on this microservice architecture, technical applications can gradually be expanded from an initial proof of concept to a comprehensive solution. From a technical perspective, a lightweight, high-performance and scalablearchitecture using open-source possibilities is important to us.

Our data analytics kit consists of the following components:

1. Back office
- Message broker for communicating with vehicles
- Service for providing object data as events
- Service for storing raw data
- Service for providing data for machine learning applications (data analyses, training models, etc.)
- Service for providing raw data according to ITxPT TiGR specification or other standards
- Dashboard for presenting and analysing data manually in real time
- Deployment pipeline for operation on a cloud-based container platform
- Deployment pipeline for applications/models

2. Communication
- Vehicle and back office communicate via message protocol (MQTT)

3. Vehicle
- Agent that is tailored to the above components and enables high-performance communication. The advantage of this is that the agent can pre-process data or autonomously perform actions based on data as needed, or where possible and available, use an existing vehicle architecture message broker. We recommend using open standard protocols wherever possible, such as the ITxPT standard MQTT bridge OTA.

The right course of action

The following course of action has proven itself effective during data analytics projects:

1. Working with the customer to identify a manageable yet beneficial specific technical application
2. Performing a technical analysis of the affected data and processes
3. Creating a proof of concept (PoC)

4. Productive prototype or minimal viable product (MVP)
5. Evolution of MVP into Version 1.0
6. Gradual further development and implementation of other applications

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Want to make use of our data analytics kit for your project?

The open and flexible kit, course of action and cooperation between Puzzle Mobility and ENOTRAC, provide our customers with key advantages:

- Thanks to the technical focus, the benefits exist from day one.
- The benefit of a manageable application can gradually be expanded into a comprehensive solution, entirely in line with the motto: 'Start small – grow big!'
- The partnership between ENOTRAC and Puzzle Mobility, along with the related extensive specialist and technical expertise, results in solutions with maximum efficiency, ensuring that technical concepts are genuinely feasible.

- We are able to draw on years of specialist and technical experience in integrating data sources (vehicles, backend systems, etc.) along with analysing and utilising them in technical applications.
- We are able to professionally version, deploy, monitor and maintain machine learning models and data.

Enotrac »»»

ENOTRAC AG is an independent and renowned engineering company in the rail sector and specialises in aspects concerning electric railways. Founded in 1987, the company is owner-operated.

PUZZLE MOBILITY

Puzzle Mobility stands for innovative and sustainable IT solutions in passenger and goods transport. We have been offering the entire range of IT services to mobility service providers for over 15 years.

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Do you want to shape the future of mobility together?

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