ProRail

The Future of Condition Monitoring within ProRail

Results of the study into the future MonitorMix

MM30

DAT(A) WERKT!

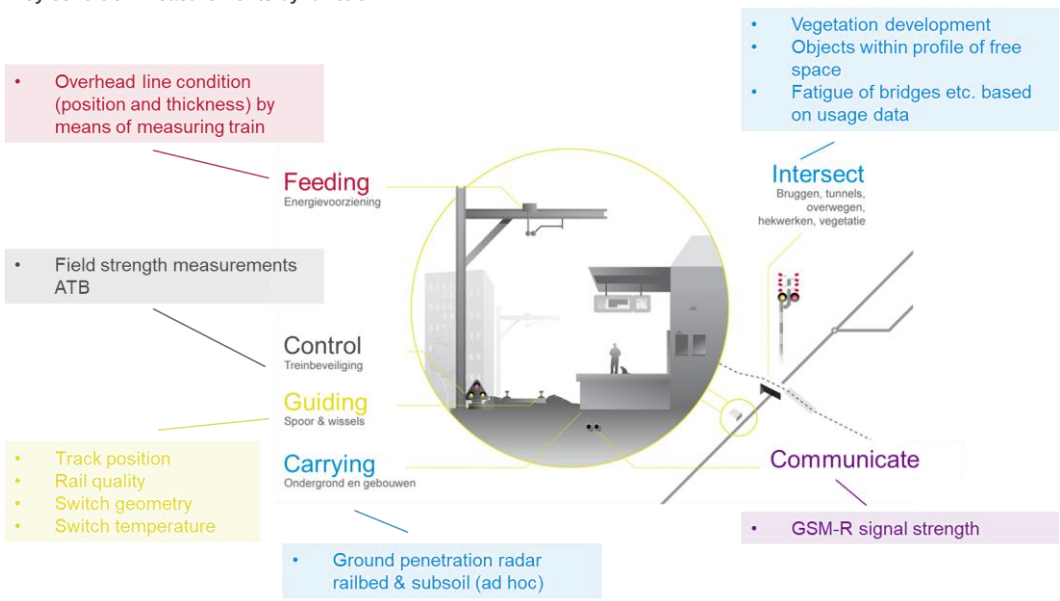
Introduction

As a railway manager, ProRail is responsible for the maintenance, renewal, expansion and safety of the Dutch railway network. Condition Monitoring is used to determine the condition of the railway assets and to predict possible failures. This enables ProRail to intervene in time and to create value by guaranteeing (and demonstrating) the safety of the network, increasing availability and reliability and optimizing maintenance and investment costs. This by maintaining and replacing assets at the right time. Condition Monitoring takes place using various measurement platforms and resources, such as measurement trains, visual inspections, smart assets, etc. We call the entirety of all measurement platforms and resources the MonitorMix.

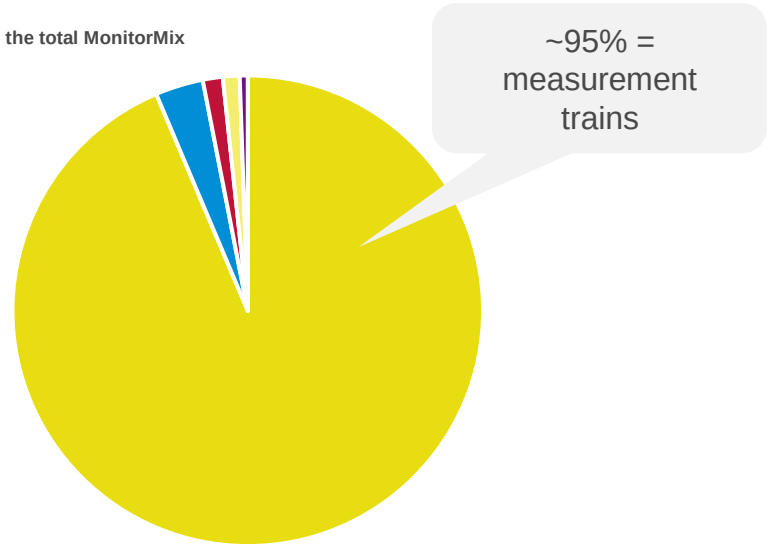
The current MonitorMix has grown historically, with the vast majority of measurements being performed with specific measurement trains. Under the influence of technological developments (smaller, cheaper, more accurate sensors/measuring techniques) opportunities arise to perform condition measurements via other measurement platforms (passenger trains, fixed sensors, drones, etc.) more cheaply, more frequently and without taking up scarce rail capacity. The market for measuring trains has now stagnated and is characterized by end-of-life assets, high costs, low margins, difficult entry and a limited number of suppliers. The dependence on one supplier is very high.

Furthermore, there is no control over the MonitorMix. ProRail has its own measurements carried out, but the maintenance contractors also measure or have them done, whereby the solution employed often differs per contract area and maintenance contractor. The condition data obtained in this way is not always shared with ProRail, as a result of which opportunities to make information from this data remain unused. Due to the lack of guidance on what is being measured and with what, there is no guarantee that everything that should (or could) be measured will also be measured and that this takes place efficiently and effectively via the right future-proof measuring platform. Meanwhile, the need for condition monitoring is increasing due to the desire to perform more preventive maintenance versus corrective maintenance.

Key condition measurements by function



Share of measurement trains in the total MonitorMix



Research questions & vision

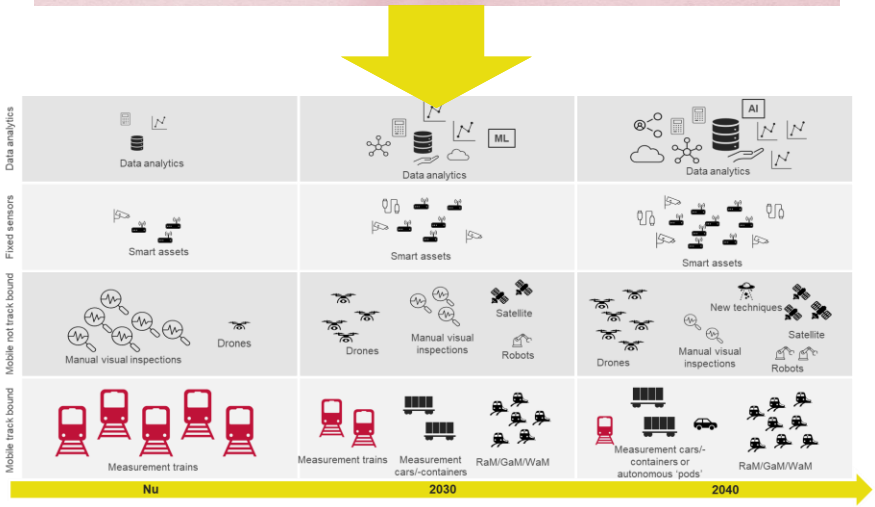
The foregoing raises the following questions:

- What does the future MonitorMix look like and what is the share of measurement trains in this?
- How can we ensure that the right measurements are performed, via the right measurement platform, that they add value and meet the information need?
- How do we make optimal use of the market for condition measurements? Or should we as ProRail do it ourselves? Make or buy?
- How do we ensure that ProRail has access to all condition data?

To answer these questions, ProRail, in collaboration with Mainnovation, conducted a study into the future MonitorMix. In this study, the current practice and developments in the field of condition monitoring within and outside of ProRail were mapped out, the sourcing strategy for condition monitoring was considered and, finally, a vision was developed for the future MonitorMix.

This vision is summarized in the following four points:

1. The future MonitorMix will become more diverse. The use of specific measuring trains will decrease in favour of measuring cars, passenger trains as measuring train (RaM), freight trains as measuring train (GaM), work trains as measuring train (WaM), smart assets, data analytics, etc.
2. ProRail will take control itself in the domain of condition measurements. Processes will be set up to inventory the condition information needs, to make choices for whether or not to measure on the basis of risk and value, and to select and develop the most appropriate and future-proof measurement platform.
3. There is a market for all elements in the MonitorMix, except for the 'classic' measurement trains. However, by changing the demand, markets can be created for this. Instead of completely outsourcing the measurement with measuring trains, ProRail will invest in modular measuring cars/containers, on which measuring systems from different suppliers can be used. The market is used for the development of these measuring systems and the operation of the measuring cars/containers. For the collection of all other condition data, the primary sourcing strategy is, or remains “buy”, whereby at least the raw measurement data is supplied.
4. ProRail becomes the owner of all condition data, which can then be combined, enriched and analyzed to determine the current condition and forecast the future condition. ProRail will develop this “data analytics” competency itself (“make”), because it is considered a core activity.



Vision 1: The MonitorMix will diversify

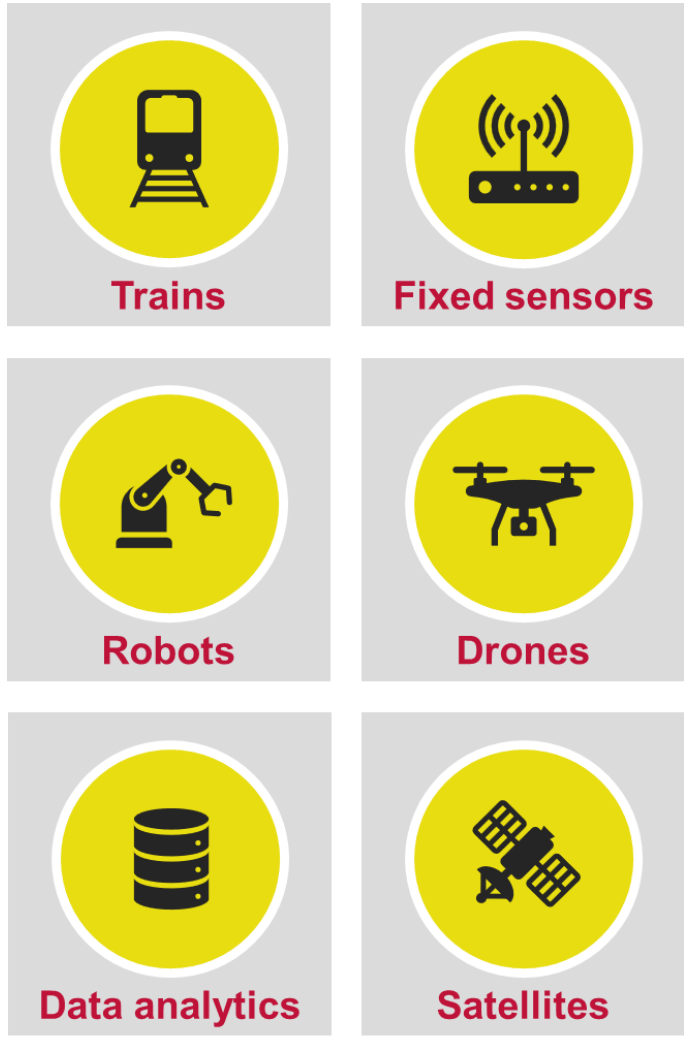
The future MonitorMix will become more diverse. The use of specific measuring trains will decrease in favour of measuring cars, passenger train as measuring train (RaM), freight train as measuring train (GaM), work train as measuring train (WaM), smart assets, data analytics, etc. In addition to measuring trains, new measuring platforms are being created, such as: fixed sensors, drones, satellites, robots, etc.

At the moment, about 95% of the MonitorMix still consists of specific measurement trains, which often perform very accurate measurements at a low frequency (1 or 2 times a year) and at low speed. As the track becomes busier, these measurement trains will become increasingly difficult to fit into the timetable. The increasing need for measurements (measuring more items, but also more frequently) cannot be met with specific measurement trains alone.

In the meantime, more and more alternatives to measuring trains are emerging under the influence of technological developments. Sensors and measuring instruments are becoming smaller, cheaper, smarter (IoT) and more self-sufficient. This makes the business case for making existing and new assets 'smart' increasingly favourable. This development also makes it easier to equip existing passenger trains with measuring instruments, so that measurements can be made at a high frequency, without taking up scarce capacity. The expectation is that there is also potential for freight and work trains.

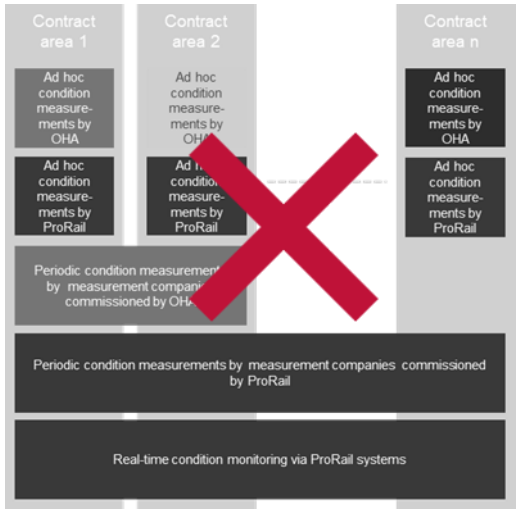
In addition to developments in the field of sensors themselves, measurement platforms are also developing rapidly, as a result of which measurements performed by drones, satellites or robots are and will be used more and more. Furthermore, Data Science techniques nowadays make it possible to determine and/or predict the condition of assets by intelligently combining measurement, usage and context data.

The need for specific measurement trains will continue to exist until at least 2030, depending on how fast the alternative measurement platforms develop. Further into the future (2040 and beyond) it is expected that they will only be needed for very specific, accurate, low-frequency measurements. For measuring trains themselves, the trend is to move from measuring trains to measuring cars, without self-propulsion and security, due to the lower investment and flexibility in the operation.

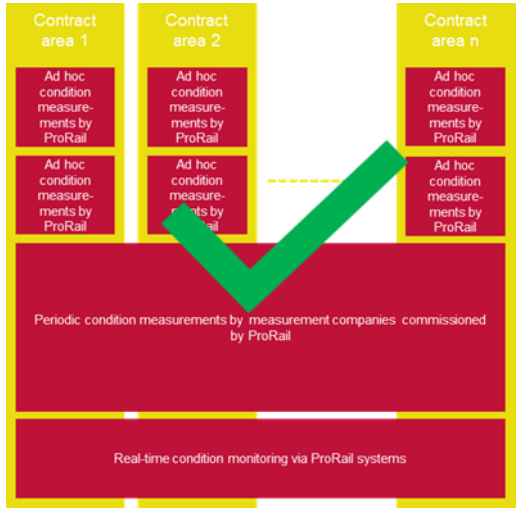


Vision 2: Take control of the MonitorMix

Current state: dispersed, not uniform



Future state: in control throughout whole chain, uniform



Various Asset Management (AM) activities require condition measurements, such as short-cycle maintenance or long-term replacements. Sometimes needs are different, but often they overlap. The condition information is often useful in multiple activities, which are carried out by different parties or departments. This requires a dialogue with all users of condition information in order to arrive at a joint statement of needs. To prevent a solution from being implemented for each individual need by each individual party, the total information need will be inventoried from all relevant angles and assessed for its added value before performing a condition measurement.

ProRail will take the lead in the domain of condition measurements. A process is set up to inventory the condition information needs, to make choices about whether or not to measure based on risk and value (for example, increasing availability) and to select and develop the most suitable measurement platform. The condition information needs of ProRail and its partners will be mapped out throughout the entire chain and kept up to date. Based on this, a choice will be made as to which measurement platforms can best be used.

ProRail takes responsibility for organizing the implementation of condition measurements. Collected (raw) data will be the property of ProRail and can be stored, combined and enriched with data from other sources. In many cases it is more practical and economical to organize measurements nationwide instead of per contract area. In addition, some measurements require relatively high investments, which the maintenance contractors cannot recoup over their contract period, with the result that no measurements are taken at all or sub-optimal solutions are used.

The responsibility for organizing the execution of condition measurements is not always explicitly assigned and data is not always fully shared. Relevant data will be made available to 'our partners' as needed - based on an agreed SLA. Currently, the delivery of data to the maintenance contractors is too voluntary, which poses a risk for them (and indirectly for ProRail as well). This also ensures that condition measurements are carried out (in a uniform manner) per contract area and over the term of individual contracts.

Vision 3: We outsource measuring

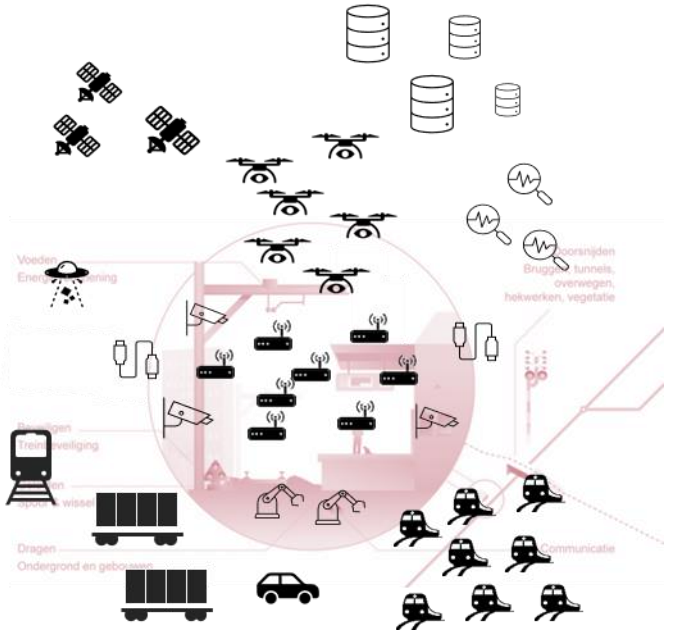
For the acquisition of condition data, the primary sourcing strategy becomes, or remains, “buy”.

ProRail is a 'management organisation', which uses the market as much as possible for operational activities. There is also a healthy market for all elements in the MonitorMix, except for the 'classic' measurement trains. Developing a 'classic' measuring train requires a high investment, while there are almost no possibilities to recoup this investment, because in Europe most rail infrastructure managers operate their own measuring trains. The risk for the market to bear these investments is therefore too great, which hinders investments, but also innovations. Doing it yourself (“make”) is also not an option, because this requires competencies that are currently not present within ProRail and also do not fit with the nature of ProRail ('management organisation'). However, by changing the demand, markets can be created for 'classic' measuring trains. In order to break open the market, ProRail will invest in modular measuring vehicles/containers and make optimum use of the market for the development of measuring systems, operation, maintenance and the supply of data. In this way, it becomes more attractive and easier for the market to offer their products and services.

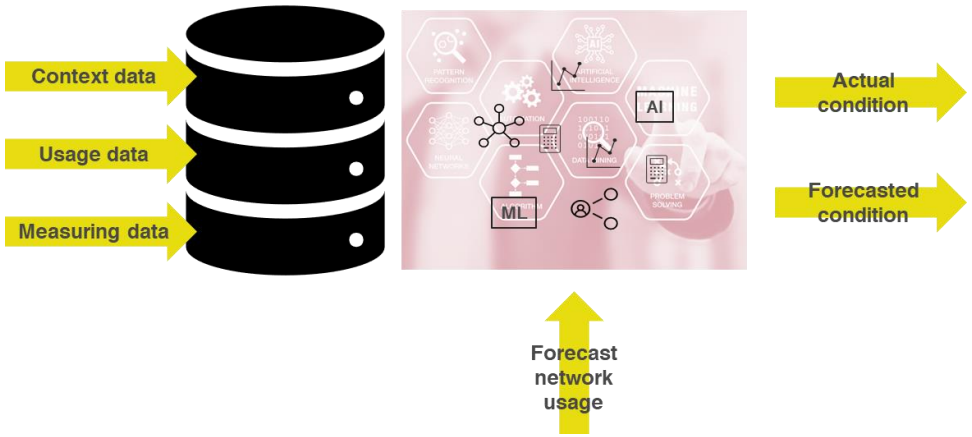
Due to this development, but also due to the emergence of other measurement platforms, the need for 'classic' measurement trains will disappear around 2030 or possibly earlier. Specific agreements will be made with the current suppliers to guarantee the continuity of their services until then.

“Buy” as a primary sourcing strategy makes it possible to take advantage of different healthy markets, reducing the risk of the emergence of single sources, as it is now. Furthermore, the possibilities to apply Commercial-Off-The-Shelf (COTS) solutions are increasing in this way.

ProRail will always have at least the raw measurement data supplied by market parties and will become the owner of all condition data.



Vision 4: We insource Data Analytics



ProRail will develop the “data analytics” competency itself. By “data analytics” we mean the combination, enrichment and analysis of data to determine the current condition and/or to make a forecast of the condition in the future. With the expected increase in condition data, it becomes even more important to turn all this data into useful information, tailored to the needs of the people who have to do something with this information. For “data analytics” the primary sourcing strategy will be “make”, because this is seen as a core activity of ProRail.

Advanced analytics, big data, machine learning, AI, …. developments in this area are progressing rapidly and large-scale investments are being made in this area within and outside ProRail (“Data is the new gold”). Instead of measuring directly, measurement data, context data (for example, meteorological data) and usage data (number of train passages, load, ..) developed models that can determine and predict the condition. In the future, these models will increasingly also prescribe what the desired follow-up action should be ('prescriptive maintenance'). The large number of similar assets of ProRail lends itself perfectly to this and the availability of usage data will only increase further in the future with the introduction of ERTMS. Furthermore, domain knowledge is indispensable in order to achieve good results together with knowledge of data science. This will increasingly become a core competency of best-in-class asset managers in the future.

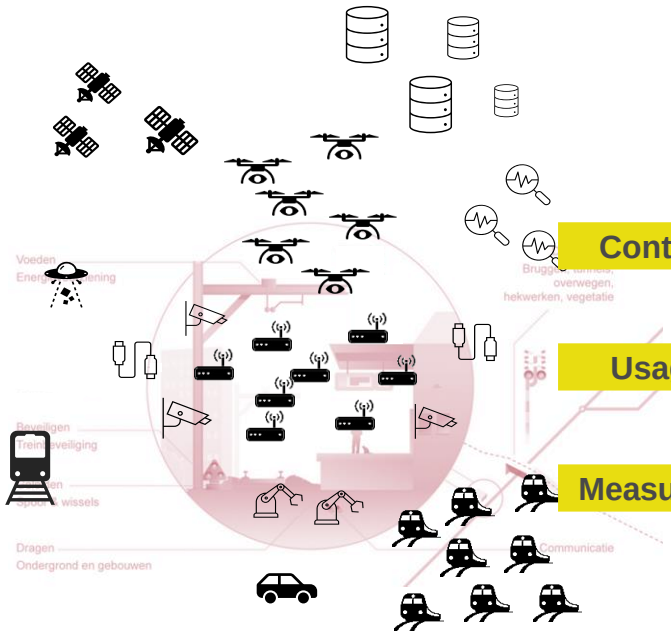
The share of data analytics in the MonitorMix is expected to increase significantly. The precise impact on the other elements, such as fixed sensors and rail- and non-rail-bound mobile measurements of the MonitorMix is difficult to estimate, because measurement data is required input on the one hand and 'data analytics' on the other hand has the potential to make measurements superfluous or reduce its frequency.

While the primary sourcing strategy is “make” for “data analytics”, the market will certainly be called upon to develop it. Furthermore, the idea is that by opening up data and sharing it with the market, innovation in this area can be stimulated even further.

The future: the role of the MonitorMix in 2030

The elements of the MonitorMix vision make the outlook below possible. A diverse and cost-effective MonitorMix provides reliable measurement data, which may or may not be combined with context data or usage data, which is analysed and provides insight into the current and future condition of the rail infrastructure. This information is presented in a useful way and delivered to the 'customers' who base their decisions on it: 'Data Driven Decision Making'.

All measurement data is the property of ProRail and is stored together with usage data and context data from external data sources.



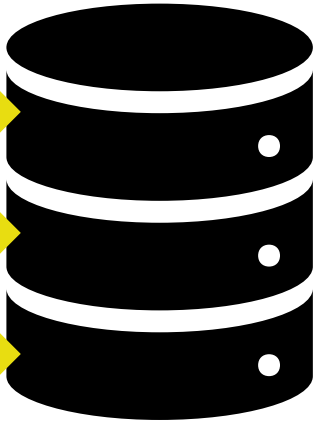
MonitorMix

Context data

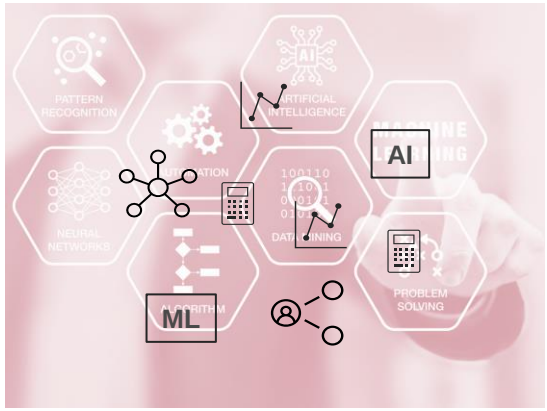
Usage data

Measuring data

The data from the different sources is combined so that it can be analysed. Using advanced data analytics, current conditions are determined and predictions are made based on expected use in the future.



ProRail data

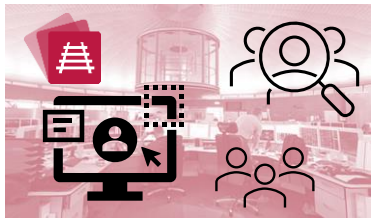


Forecast network usage

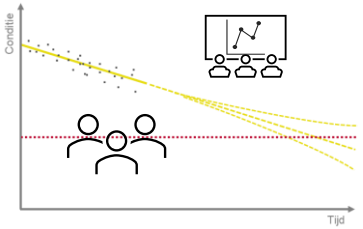
The current condition is reported and monitored in the Asset Health Centre. The data is made available to relevant users, for example the maintenance contractors (single source of truth).The forecasted condition is used to forecast and schedule investments/replacements.

Asset Health Centre

Actual condition



Forecasted condition



Data is used for short-term (maintenance planning) and long-term (replacement planning) decision making → **Data-driven decision making**

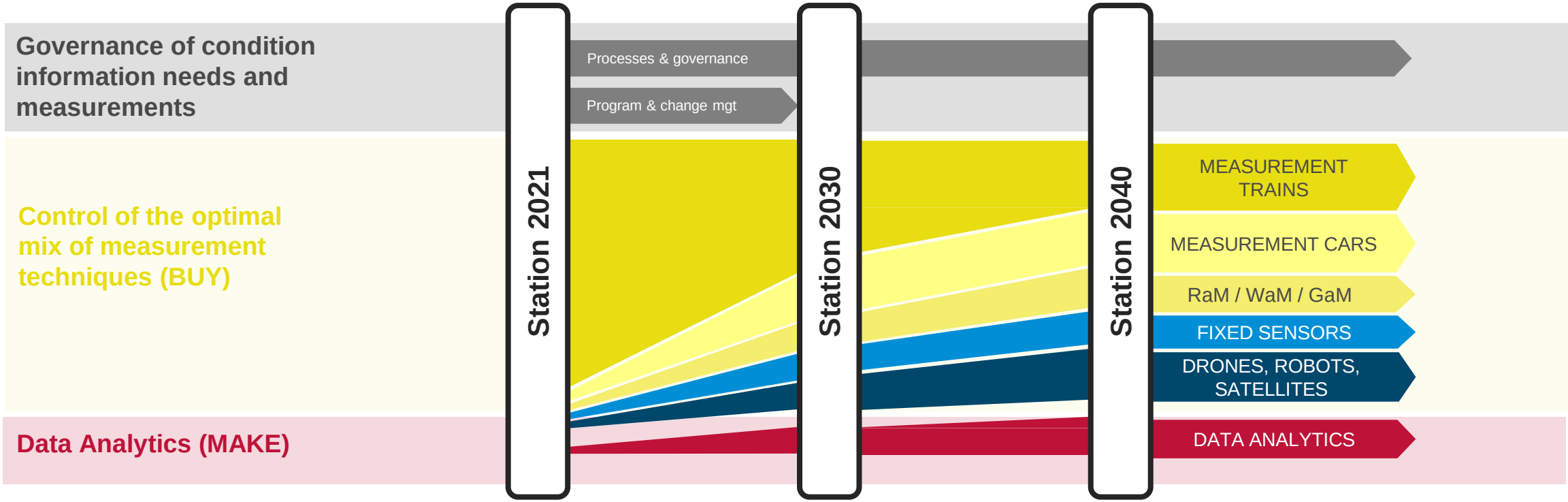
How to proceed? Realization of the vision

A program has been launched to make the vision a reality. This program aims to:

1. Realize the vision of the MonitorMix 2030 and adjust it where necessary in the future
2. Embed the development and management of the MonitorMix 2030 in the processes and organization of ProRail (“taking control”)
3. Actively manage the use of the right measurement platform and the right measurement techniques to meet the condition information requirements
4. Achieve data-driven working by implementing the entire chain from inventorying the condition information need to the actual use of this information

The program will therefore also provide guidance for the prioritization of all current and yet to be started initiatives and projects, whereby the program will guarantee coherence and the right focus.

The program is divided into a number of streams, including one for setting up the necessary governance, but also streams in which all projects and activities related to existing measurement platforms (mainly measurement trains) and measurement platforms to be further developed are bundled.



Questions? Please contact the program organization!

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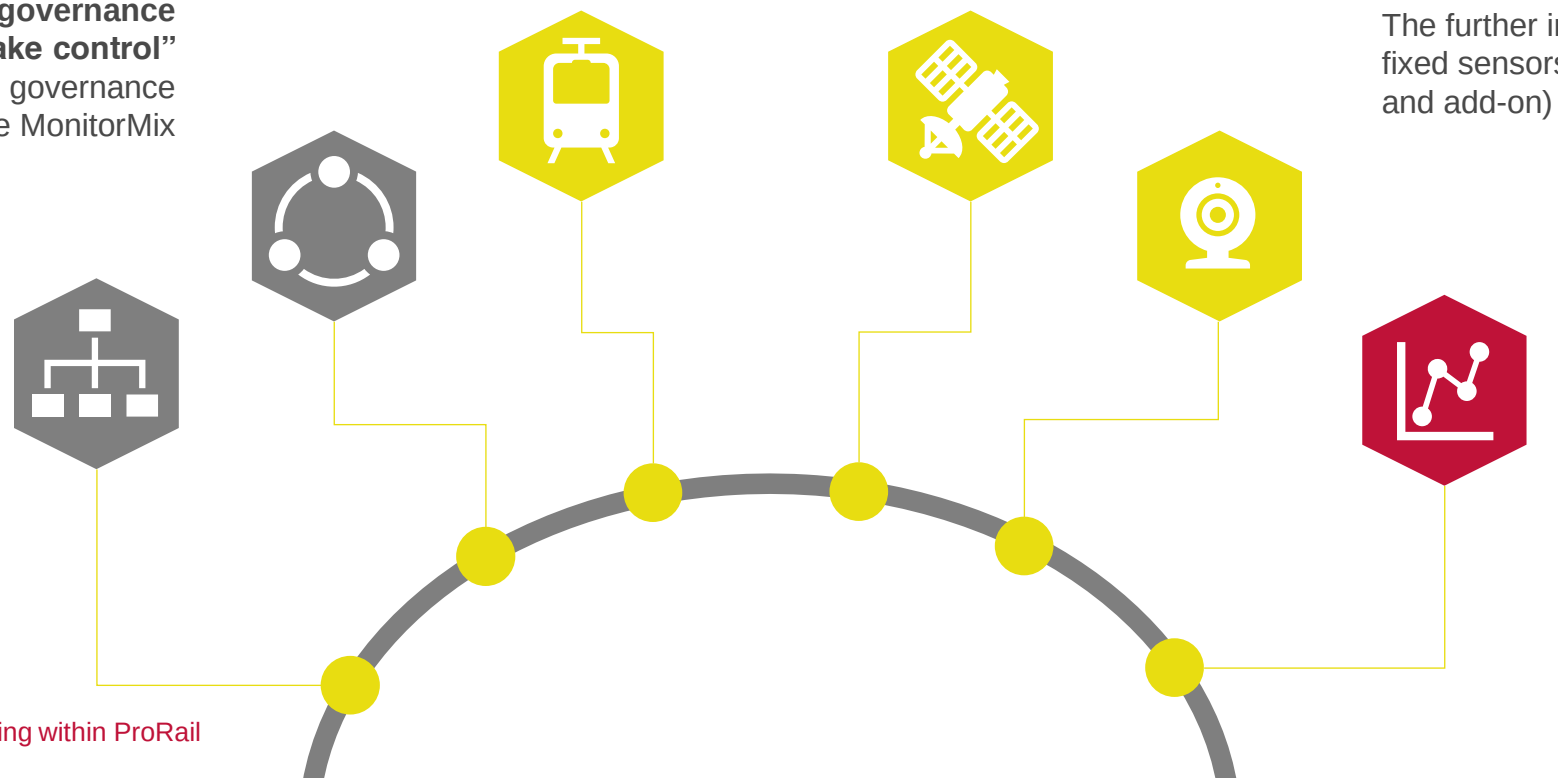
- Mobile measurements: Frank Vermeulen (frank.vermeulen@prorail.nl)
- Fixed sensors: Paul Kootwijk (paul.kootwijk@prorail.nl)
- Data analytics: Thymo van den Brug (thymo.vandebrug@prorail.nl) or Douwe Treurniet (douwe.treurniet@prorail.nl)

Guarantee continuity measuring trains
Keep the current measurement trains running until alternatives have been implemented

Mobile measurements
The development of alternative mobile measurements, which will largely replace the current measurement trains

Processes & governance "Take control"
Set up the governance processes of the MonitorMix

Fixed sensors
The further implementation of fixed sensors (both embedded and add-on) in the rail network



Program & Change management
Guiding, monitoring and securing the transition

Data analytics
Further setting up and expanding the data analytics competence within ProRail

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