# Enabling Transition to Predict and Prevent Maintenance Regimes

## What is the situation?

We have made significant progress in delivering efficient and effective maintenance, providing the foundation for our strategy:

- Improvements have been made understanding and monitoring the asset base resulting in the lowest number of service-affecting failures of all time.
- Aspects of our infrastructure monitoring capability are recognised as best in class. Broken rails have been below our control limit for 12 of the previous 13 periods.
- Excellent progress has been made with defining and implementing reliability centred maintenance regimes.

Despite these improvements, there are further opportunities:

- CP5 Maintenance expenditure has not reduced at the rate forecast at the start of the control period.
- Delay due to asset failure is increasing despite the number of failures falling.
- Track access required for maintenance does not align to train service specifications.
- Condition monitoring data is not yet utilised to generate predictive and preventative maintenance regimes.
- Potential reduction in renewals volumes in CP6 will require effective and high-quality maintenance task delivery to maintain the sustainability and performance of the asset base.
- The data currently held does not have the quality and granularity required to fully deploy predict and prevent maintenance.
- Maintenance regimes are not optimised based on risk and need to be effective at balancing spend against the impact of asset failure.

## Analysis of causes
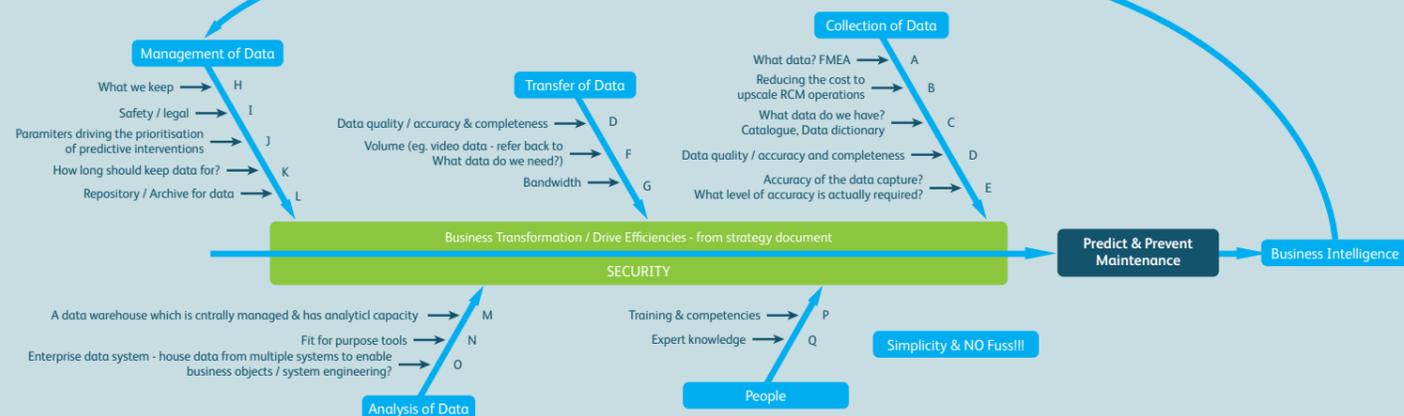


## Priority Problems

### Specific Priority Problems

- Advanced analytics are not utilised to understand asset condition and define timing and type of maintenance intervention.
- Data sources are not integrated and analysed to understand how the railway is performing as a system.
- There is no defined systematic approach to optimise maintenance regimes based on performance risk.
- Insufficient sensor capability has been deployed to either fixed or mobile infrastructure.

### Related Goals

- Exploit existing data sources to enable improved decision making, optimise maintenance regimes and prevent asset failure.
- System based analysis (e.g. between track geometry and points RCM) will further improve predictive capability.
- Maintenance regimes are optimised to reflect the impact of failures in each location.
- Improved capability to predict and prevent asset failure and optimise maintenance regimes.

### Benefits

- Reduced maintenance and renewals cost, improved train performance and safety.
- Enables trade-offs in maintenance spend to benefit train performance.

## Scope

The challenge is to explore where sensor technology and analytics can be combined with robust Failure Modes, Effects and Criticality Analysis (FMECA) to enable a prioritised transition to predictive and preventative maintenance.

Activities required to deliver this are:

- Deployment of technology to provide cost-effective data capture and transfer, utilising both fixed and mobile sensors.
- Software to support rapid deployment of demonstrators for technology, analysis and prognosis.
- Cost effective data management and analysis of monitoring systems fitted to service trains.
- Deployment of enhanced analytics on existing data sources to develop prognostic capability, including the development of health scores for each individual asset/junction/ELR.
- Development of a system, fully integrated with our fault and asset management systems, to enable data technicians to monitor asset health and prescribe maintenance regimes.

## Specific research needs

To address these challenges it is expected that R&D actions will need to focus on the following aspects:

What remote condition-monitoring technologies are available for deployment to predict and prevent asset failure and/or replace existing manual maintenance regimes beyond solutions already embedded or in a trial in our Intelligent Infrastructure system? There is a requirement for:

- Level crossing monitoring – c. 1400 assets.
- Train borne monitoring of Signalling Equipment – initial pilot on NR monitoring fleet with potential for fitment to in-service trains.
- Train borne monitoring of S&C – it is anticipated up to six trains may be required.
- Ideas/prototypes/demonstrators/systems that are in use/development in other railways/industries.
- Overcoming recording speed constraints with current data collection technologies e.g. rail flaw, eddy current – there are currently five systems in use on a dedicated monitoring fleet.
- Transition to unmanned systems on our fleet of monitoring trains.

Provision of additional insight from existing data sources. Pilots for diagnosis of points condition and prediction of track circuit failures have been developed and will be tested in the near future but there are many other opportunities:

- Expand points condition diagnostics to predict asset failure.
- Expand track circuit predictions to diagnose failure modes.
- Develop prognostic capability for all assets fitted with condition monitoring.
- Development of algorithms to establish degradation rates of our linear assets, utilising the outputs to improve planning of maintenance intervention, in particular for on track machines.

Provision of additional insight through the integration of disparate data sources. Examples identified are:

- How can points condition monitoring and train-borne monitoring data be integrated to understand the effect of poor track conditions on the life and reliability of points operating equipment?
- What is the performance risk of overhead line heights and staggers position moving away from the original design whilst remaining compliant to existing standards?
- How can changes in track stiffness be used alongside age and condition data to predict and prevent broken rails?
- Analytics developed in other railways or industries that could be transferred to Network Rail.

Creation/configuration and integration of a system bringing together the analysis created by the above schemes. This will enable the systematic and regular reassessment and optimisation of maintenance regimes in line with current asset performance.

Creation of a systematic and robust risk assessment approach utilising cross-discipline FMECA. Enabling trade-offs between maintenance-spend and the impact of asset failure where condition monitoring is or isn't fitted.

## Expected impact & benefits

- Optimised maintenance costs, which could be increased if this provides a greater reduction in renewals cost.
- Delays per incident are reduced through use of diagnostic capability.
- Increased workforce safety.
- Improved train performance.