



Decreasing the Impact of Extreme Weather for Rail

The **Timetable Optimisation for Extreme Weather** project is taking a significant step towards **reducing** the **negative impact** of extreme weather events on the **UK rail network**, minimising delays and improving passenger service.

The project was funded by the Department for Transport through Innovate UK's First of a Kind 2023 competition. CFMS has produced a unique tool for **creating optimised train timetables** to minimise disruption during extreme weather events, significantly changing how Train Operating Companies (TOCs) respond to their increasing occurrence. Created with insights from Great Western Railway (GWR) and Avanti West Coast, the tool is **validated on real-world data**, offering a direct comparison with real-world events.

Challenge

When extreme weather events hit the UK, Network Rail **imposes temporary speed restrictions** and line closures across the rail network. This often leaves TOCs **only 24 to 48 hours** to create adjusted timetables. Creating a new timetable is a manual process with separate data sources and a significant number of variables to consider, each with its own unique set of characteristics. Often, the information and behaviours of each of these variables are only known by individuals on the planning team, further adding to the complexity of the process. This leads to a **strain on resources**, **sub-optimal timetables** being run and a **reduction in service**.

Not only does this lead to **poor passenger experience**, but it also incurs **financial penalty payments** for TOCs.

The aim of this project is to:

- Enable planners to get to a better starting point to replan timetables faster
- Develop an optimisation tool that provides candidate timetables rapidly for further iteration
- Produce relevant outputs in data formats consistent with other tools
- Create an easy-to-use user interface to quickly execute workflows
- Enable the sharing of information to customers and other teams sooner so that appropriate action can be taken.

Solution

Utilising modern optimisation techniques and compute capabilities, CFMS has built a tool to **rapidly generate candidate timetables**, enabling planning teams to reach a better, optimised timetable more quickly. The tool takes the baseline timetable (LTP/STP), geographic information and the temporary speed restriction(s) and

Storm Eunice

Utilising historical data for Storm Eunice, we validated the effectiveness of the tool. Data from journeys that ran on the GWR **Paddington to Swansea** line was used. A **50 mph temporary speed restriction** was enforced across the whole network on the **18th of February 2022**, from **04:00 to 19:00**. Journeys that were scheduled to travel in Wales were terminated at Bristol. Delay minute data was available for **37 journeys** that ran on-the-day.

Exploiting our tool, we created candidate timetables to alleviate the strain placed on the network.

Actual Delay Minutes	Delay Minutes Using the Tool
1822	640
Reduction of 64%	

Whilst this doesn't account for on-the-day events, stock or crew, being able to produce a significantly better starting point would have a positive impact on reducing delay minutes and improving passenger services.

outputs re-timing data and insights that are used to **support decision making**. The information is entered into a user-friendly interface that can be accessed from a web browser, eliminating the need to download software. Speed restrictions can be specified by the start/end time, the start/end locations and the speed of the restriction itself. Numerous restrictions can be entered for multiple different parts of the line representing moving weather fronts or events on the same day.

Utilising our secure, onsite HPC data centre, we can then **analyse a very large number of candidate timetables** in a **short amount of time** to determine a robust, optimised solution to minimise delay or disruption. For timetable planning teams, this provides greater automation of time-consuming tasks, creating additional time for more labour-intensive tasks such as crew management.

Additionally, our tool enables a large number of scenarios and variations to be analysed. This breadth of analysis facilitates the creation of **more robust timetables** and allows for better planning for a wide range of possible scenarios. This can also be used outside of extreme weather events to support the planning of baseline timetables.

The tool's primary output is **re-timing information** that is both **human-readable** and **machine-readable**. This can be amended depending on the individual TOC's requirements. The human-readable format is extracted and displayed in a variety of reports reducing the time spent on collating potential timetables.

Insights can be drawn from the candidate timetables enabling better quality decision-making, e.g., Network Capacity Graphs can be used to understand the proposed timetable's impact on capacity, informing which cancellations to make. The data can also show which trains are the most/least delayed and where on the line. Hypothetical scenarios can also be tested and analysed allowing for **proactive decisions** to be made.

Benefit

Early validation on real-world historical data has shown that the tool would have produced a reduction in delay minutes of **45-65%**. This reduction is significant and would reduce TOC On-Self cancellations, delay penalties and delay repayment costs, which are a large proportion of TOC annual spending. Furthermore, the tool provides the ability to measure the impact of restrictions in advance by testing specific scenarios. The tool provides further robustness to timetables allowing the TOCs to better cope with unexpected on-the-day events, or replan at short notice when additional challenges arise.

Critically, through the automation of time-consuming processes, the tool **reduces controller workload**, giving back time to planning teams. This can then be used to plan other aspects that are impacted by an extreme weather event such as crew or stock management, helping to reduce delays or cancellations related to crew availability.

This all leads to **better passenger experiences** with greater notice for amended timetables meaning passengers can plan their journeys accordingly. It will also help with fewer on-the-day delays or cancellations, improving journey times. This is particularly relevant with the growing need for sustainable travel solutions and the desire to increase the use of public transport.