Strategies for the use of Data and Algorithmic Approaches in Railway Traffic Management

Presented by Resonate

Industry Background

There has been much work over many decades on modelling the generation and optimisation of railway timetables. Much of this focusses on relatively simple railways and services and is therefore quite straightforward. Main line railways have a number of features that introduce significant complexity.

- Routes with many junctions and intersections
- Variable train speeds
- Variable train stopping patterns
- Mixed passenger and freight traffic
- Peak patterns / off peak patterns
- Tidal flows in and out of cities for the working day
- Constraints from resources (trains and crew).

As the volume of traffic in the system increases, the effect of perturbations in the actual progress of trains can introduce unstable behaviour that provides significant challenge for the compromise between performance and capacity. Traffic management systems are therefore needed to forecast the likely future progress of trains, identify conflicts, and modify the planned schedule of trains to minimise the resulting disruption and accelerate recovery back to the planned service.

Company background

Resonate is a technology company specialising in rail and connected transport solutions. We have a powerful platform and an excellent team that is helping us to support numerous elements of the Digital Railway initiative being driven by Network Rail and the DfT. We are also working hard to help deliver intelligent traffic management and smarter cities internationally.

We have over 50 years of rail industry experience and used to be the research division of British Rail before being privatised in 1996. Our understanding spans safety critical signalling control, rail operations management, logistics and IT. We have combined our rail background knowledge with agile development methods, data gathering, advanced algorithms and the latest cloud computing, so that we have the tools to deliver 21st century traffic management.

In 2016 we changed our name from DeltaRail to Resonate in recognition of the fact that we are entering a new and demanding age of connected and intelligent transport. We have embarked on a drive to maximise capacity and performance through predictive intelligence, shared data, joined up travel and informed customer journeys.

Problem Statement

A Railway Traffic Management problem can be defined as

- Forecasting future progression of trains
- Identifying conflicts where two or more trains compete for available infrastructure
- Investigating options for resolution of conflicts
- Re-planning train schedules to minimise the impact on system performance.

Traditionally the problem of re-planning a timetable in near real time to manage and recover from service perturbations and disruption is simplified to help arrive at a solution in an acceptable amount of time, but this then can have unintended consequences which can amplify rather than reduce the disruption.

We would be interested to look at different strategies / models / techniques for dealing with the problem, the likely strengths and risks of these, and how they might be adapted to improve existing solutions.

Performance management of complex networks is a problem common to a number of industries and applications and therefore it is likely that approaches already exist that could be adapted for use in rail.

Detailed data on planned services and actuals over many months is available to support the workshop.

Constraints

A number of constraints can complicate the timetable optimisation and have a significant impact on the robustness of a solution:

- Availability of infrastructure – typically during disruption, the level of infrastructure available is reduced, either by a failure of the equipment, or a blockage caused by train failures or human intervention.
- Availability of rolling stock (their location, and the fact that there are various different types of train, with differing requirements for maintenance and capacity)
- Availability of staff (location, ability to drive certain trains & routes, shift hours).

Costs & Benefits

The primary benefit of improved railway performance is of course to the passengers, freight operators and the UK economy. In addition to this:

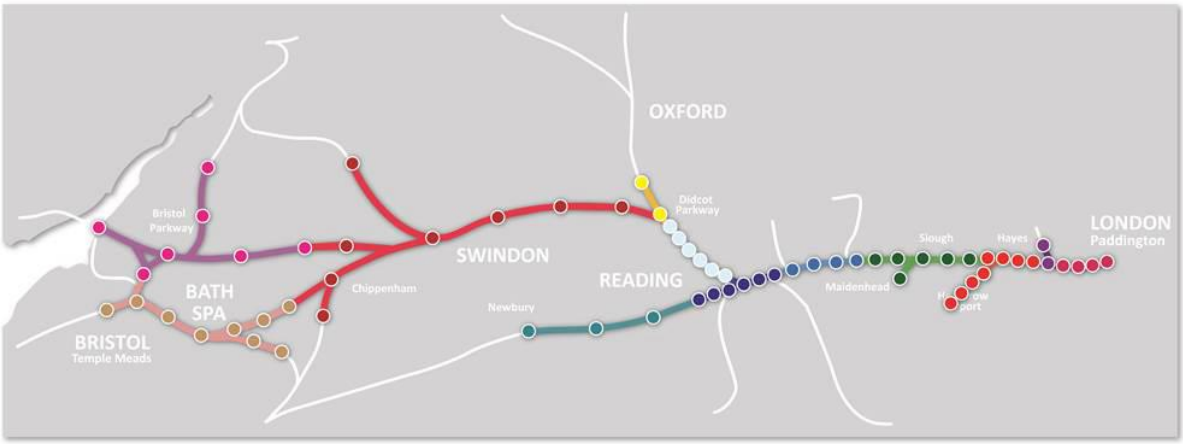
- The Rail Regulator can fine Network Rail for failure to meet performance targets – the last fine was £53m in July 2014.
- There is a delay attribution regime in place between Network Rail and Train Operators where the originators of delay pay compensation to those who suffer delay – typically £100m can change hands across the industry in a year.
- There are additional costs for reimbursing customers for delays or reduced services.
- Customer service is important, often measured indirectly through the number of trains calling at each station compared to planned operation.

There is therefore also a good business case for minimising train delays.

Focus on Western Route

We propose that the Study Group focusses on the Western Route between Bristol and London Paddington Station. This route has three parts

1. London Paddington to Reading - a busy feed into a major London terminus
2. West of Reading - a larger area with many individual feeds into the main line
3. Reading Station - a major intersection between the two



This presents a number of scenarios that can be used as part of the study eg.

- Long distance trains (Swansea – Paddington) aiming for a tight slot between Reading and Paddington
- Trains from branch lines entering the flow on the main line West of Reading
- Freight trains needing to cross the main line
- Potential infrastructure failures leading to partial blockages.

There are a number of different service providers: Great Western Railway, Cross Country and Arriva Trains Wales providing passenger services, and a number of freight operators also operate across the route.

Currently, performance on the route is largely measured in terms of the number of trains that arrive within 5 or 10 minutes of the published timetable (the shorter distance, commuter services carry a 5 minute target and longer distance services carry a ten minute target).

On a good day (one with no major incidents), approximately 95% of services meet their target. Recently, average performance has been closer to 80%.