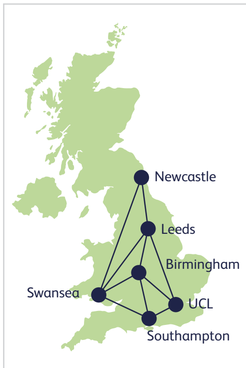
Future Train Regulation Optimisation (FuTRO)

Future Traffic Regulation Optimisation (FuTRO) is a part of the Rail Technical Strategy (RTS) vision for intelligent traffic management and control systems that dynamically optimise network capacity and facilitate highly efficient movement of passengers and freight.

February 2018



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Glossary of terms

C-DAS	Connected Driver Advisory Systems
DEDOTS	Developing and Evaluating Dynamic Optimisation for Train Control Systems
DITTO	Developing Integrated Tools To Optimise Railway Systems
ETCS	European Train Control System
FuTRO	Future Traffic Regulation Optimisation
RSSB	Rail Safety and Standards Board
RTS	Rail Technical Strategy
TRL	Technology Readiness Level
TMS	Traffic Management Systems
TLG	Technical Leadership Group

Overview

FuTRO is a key research programme required by the Rail Technical Strategy and stakeholders to define the railway of the future.

FuTRO addresses the requirements, capabilities and key attributes needed to achieve the 30-year vision of the Rail Technical Strategy. FuTRO's primary purpose is to develop algorithms for optimised traffic management and thereby it supports migration towards the Digital Railway.

A Capability Delivery Plan essential for delivering the Rail Technical Strategy is shown in Figure 1. Intelligent traffic management links to over half of these key capabilities. This overview describes the developments of the algorithms and their use, as well as looking forward to what should be possible. The information is for industry research managers to decide funding for further work or testing.

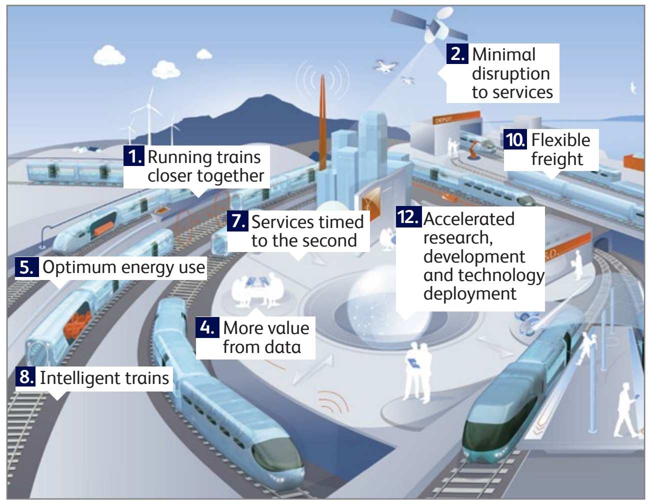


Figure 1: Capability Delivery Plan

Traffic Management systems using such algorithms will be highly flexible and capable of optimising railway operations at network, route and individual train levels. Objectives for a variety of traffic can be met at different times of the day. Capacity, speed, timekeeping, energy savings, operating costs and asset management can be prioritised in real-time as needed.

These systems are highly reliable and resilient, to support the delivery of normal or near-normal services during all but the most exceptional circumstances.

Significantly improved railway operational performance must bring together real time operational, asset, and customer data. This will support regulation of traffic in an optimal way, meeting commercial and regulatory priorities. One of the problems to be addressed is the lack of optimisation methodologies, criteria, and approaches.

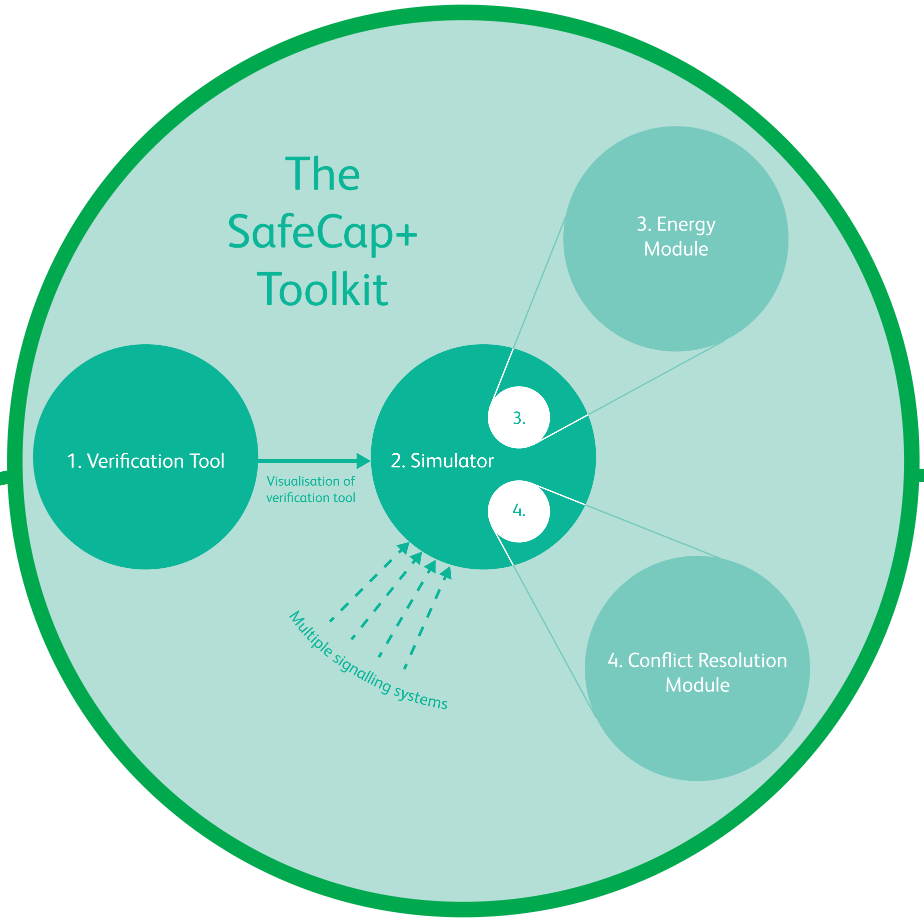
Advanced, intelligent and automated traffic management systems should progressively replace existing systems in control centres. TLG's FuTRO project is helping to deliver the frameworks for the concepts, requirements and architectures of next generation traffic management systems.

These systems should be dynamic and able to optimise the use of the rail network, minimise delay, optimise traction energy use and maintain train connections for passengers. Data from trains and the infrastructure should predict where and when conflicts are likely to arise and offer or implement solutions in real-time.

Operating data should also be used to feed automated long-term planning systems to optimise train timetabling and infrastructure use.

The three academic projects that form part of FuTRO: Increase Fundamental Knowledge for Optimising Traffic Management are SafeCap+, DEDOTS and DITTO.

These have been completed, and brochures for the individual projects and the detailed results are available on the SPARK website: www.sparkrail.org



1

SafeCap+

Reducing design and testing time of signalling schemes from months to minutes.

The SafeCap+ project has developed a number of tools that help signalling engineers to formally verify safety as well as to calculate node capacity for various traffic scenarios.

Even though the tools developed provide several high-level functions to design a train control system, further improvements are necessary to make it is easier for railway engineers to develop and model real systems.

Future steps should include developing a rich signalling library, which will include a range of conventional and more complex signalling systems. This would allow railway engineers without prior knowledge of programming to experiment with and explore various combinations of mixed-signalling railway networks.

Figure 2: SafeCap+

Figure 3: DEDOTS

2

DEDOTS

Right Place, Right Time and Right Speed.

The DEDOTS project will help optimise traffic capacity on the network. It does this by controlling train speeds and sequences to increase capacity at critical locations.

One strength of the DEDOTS evaluation process is its ability to co-ordinate conflicting parameters that determine the capability of the system under test.

These include traffic heterogeneity, the required frequency of optimisation, and size of control area. The process outputs are also highly visual.

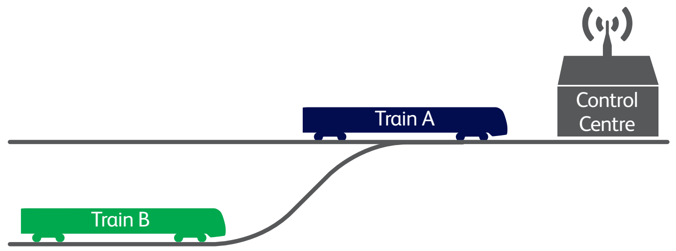
Rail Technical Strategy	• Real-time traffic management • High capacity, energy-efficient, on-time
Strategy	• Right place, right time and right speed
Method	• Use of real-time data on train position and speed • Dynamic optimisation of train movement

Further development will be needed, using simulators, before the system can be taken to an implementation trial. These simulators must be verified as being capable of working accurately and consistently with non-proprietary data and communications protocols.

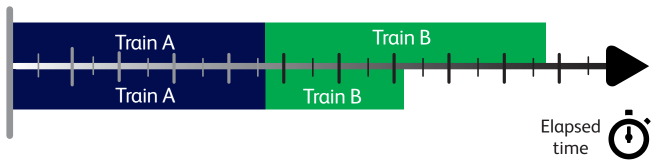
A follow-on project is already underway involving an industry trial of Connected Driver Advisory Systems (C-DAS), using the DEDOTS algorithms.

Increasing Junction Capacity

Normal Practice: Train B stops at a red signal. After the signal clearance, Train B accelerates and passes the junction (and thus needs a long time).



Future Practice: Based on Train B's arrival time and speed being controlled, there is no unnecessary acceleration and hence shorter junction occupancy.



3

DITTO

Optimal Performance through design and planning

The DITTO project develops and integrates tools that can be used during various stages of optimising the rail life cycle.

At the network optimisation and plan optimisation stages, capacity is maximised whilst ensuring safety. Plans are created to minimise congestion related reactionary delays. Enhanced scheduling algorithms are developed and tested.

At the operational level, this will involve optimising train management by examining train-following rules for ETCS Level 2, Level 3, and beyond.

At the performance monitoring stage, results such as build-up of reactionary delays are analysed to provide feedback into the initial stages.

The next steps for the programme would be for the partners in all three projects to work together, to develop integrated tools that will help shape the future of traffic regulation optimisation in the railways.

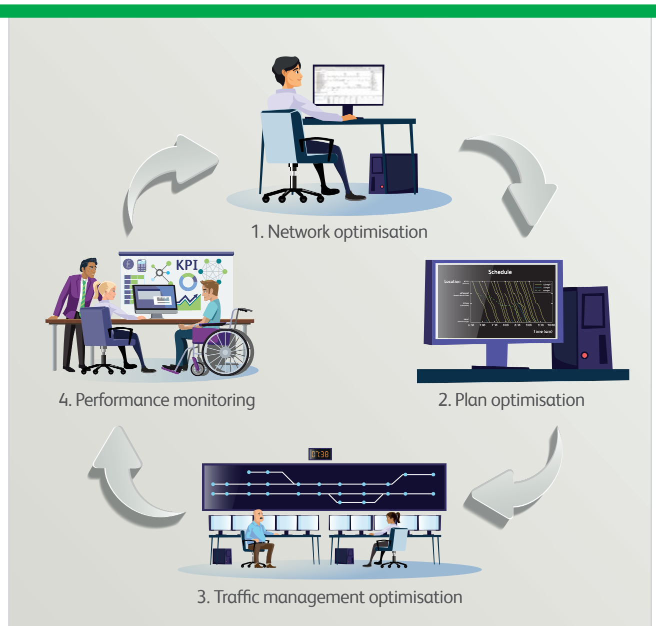


Figure 4: DITTO: Optimising the Rail Life-Cycle

Figure 5 shows the trajectories and speed profiles of two trains when Optimised Separately (Left) and Simultaneously (Right). This clearly indicates how optimizing energy leads to fewer decelerations and accelerations.

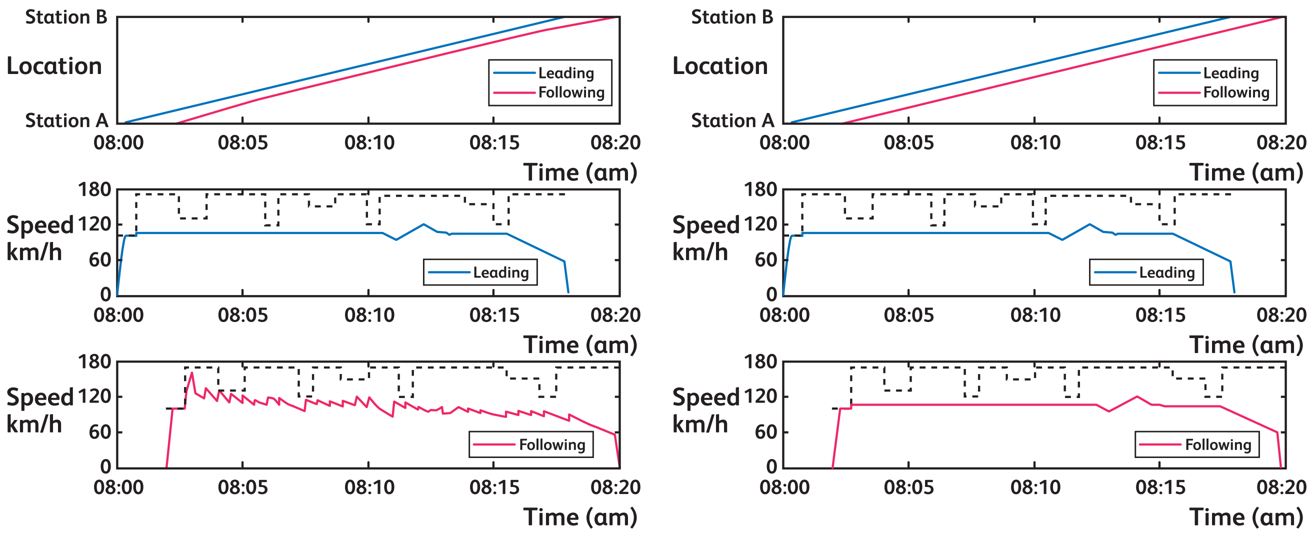


Figure 5: DITTO: Trajectories and speed profiles of two trains

Future Steps

The outputs from the research have already led to a number of future implementation initiatives. These are listed below by project:

SafeCap+

1. The next step would be to develop a rich signalling library, which includes a range of conventional and more complex or novel signalling systems. This would allow railway engineers to use the simulator (without programming expertise) to experiment with and explore various combinations of mixed-signalling railway networks.

2. Current work is developing the ability to work with SSI (Solid State Interlocking) data. Next steps would be to develop interfaces to different products.

3. Ongoing work focuses on developing a full prototype of the advisory system, followed by its integration into the SafeCap toolset. The next step is to integrate an advisory system into the proprietary simulation environment used by the industrial partner (Siemens Rail Automation).

DEDOTS

4. The next steps for the Optimisation Framework will be to develop this work to higher technology readiness levels. This will use enhanced simulators that must work accurately and consistently with non-proprietary data and communications protocols.

5. A trial is now underway to implement the DEDOTS system in TMS/C-DAS environments. As a first step, the optimiser performance has been evaluated using the real train movement data of East Coast Main Line.

6.Initial integration work is ongoing to integrate DEDOTS with Transportation Technology Group's C-DAS system.

DITTO

7. The consortium members of DITTO will continue to work together, and in conjunction with their partners in the DEDOTS and Safecap+ projects, to develop integrated tools that will help shape the future of traffic regulation optimisation in the railways.

8. The University of Leeds is exploring the optimal train control algorithms developed in DITTO to examine energy efficient automatic train control in conjunction with the Beijing Metro.

9. Swansea University is in discussions regarding the deployment of the OnTrack system in Thailand.

10. At the University of Southampton, work will continue to extend the Capacity Utilisation Index and Congestion Related Reactionary Delay analysis.

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