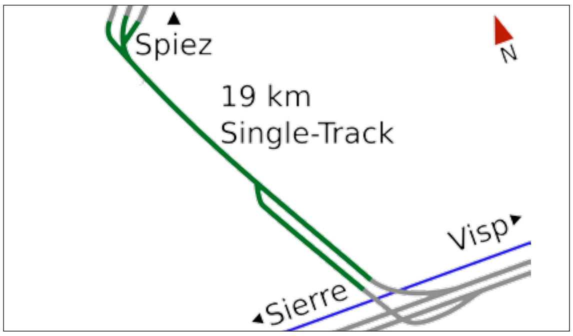
Michael
Gerber

Alain
Kaeslin

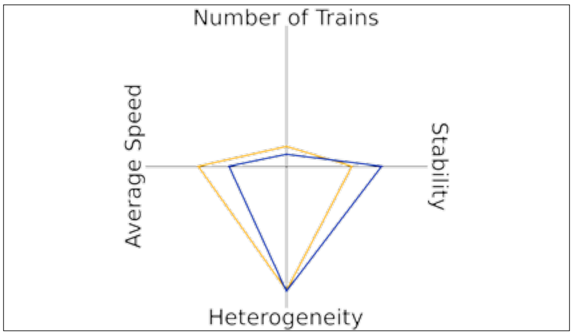
Graduate Candidates	Michael Gerber, Alain Kaeslin
Examiner	Prof. Dr. Luc Bläser
Co-Examiner	Dr. Farhad Mehta, systrans AG, Rotkreuz ZG
Subject Area	Software
Project Partner	systrans AG, Rotkreuz ZG

Simulating and Evaluating the Lötschberg Train Traffic System

Case Study



Topology of the Lötschberg Base Tunnel. 19 km of the 34.6 km is comprised of a single-track section.

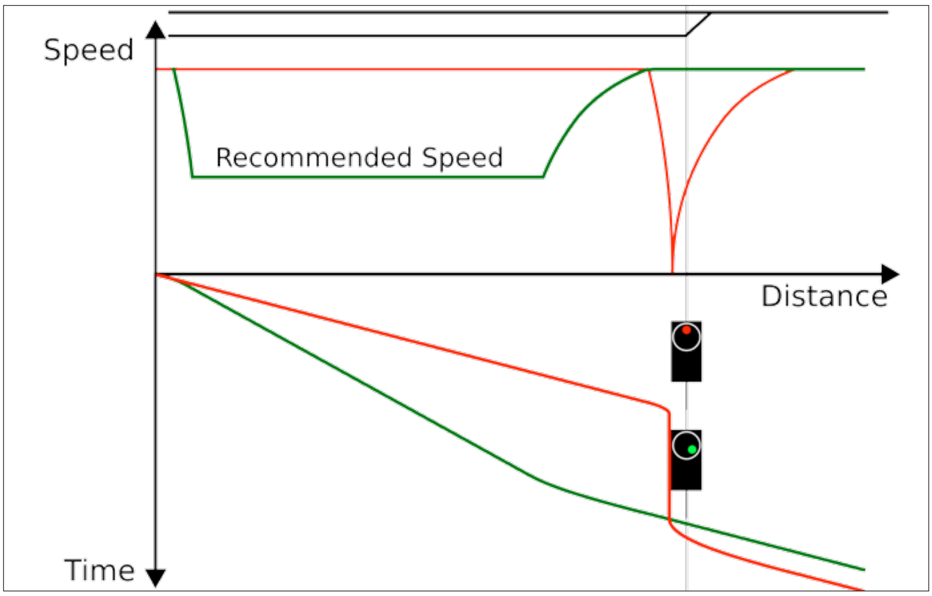


The four capacity indicators shown in a spider chart. The example illustrates typical operation during daytime (yellow) and night time (blue).

Introduction: The Lötschberg Base Tunnel is a 34.6 km long railway tunnel, consisting of a 19 km single-track section. This poses particular challenges for the tunnel operation to minimise track occupation conflicts. For this reason, a train traffic control system is in operation that forecasts train movements, calculates optimal speed trajectories and sends corresponding advisory speeds to the train drivers who can in turn adjust their speed. The aim of this thesis was to analyse the added benefit of the existing control system compared to an operation without speed recommendations, and investigate on further possible improvements.

Approach/Technologies: We have developed software to simulate conflict situations with and without an advisory speed system. The results are shown in combined speed-distance, force-distance and time-distance plots. This visualisation enables an in-depth interpretation of the conflict situation and driver behaviour. To evaluate the overall impact we calculated four main railway line capacity indicators using a quantified model. They can be compared in a spider chart in our web-based analysis tool.

Result: While the results show only slight improvements in the overall capacity gain as most trains travel through the tunnel conflict-free and cannot benefit from the advisory speeds, some significant delay reductions are obtained for conflict cases. The advisory speeds in combination with the observed ecological driving behaviour result in efficient energy usage. Our evaluations also show that a detailed vehicle dynamics model is key to the crossing conflict optimisation algorithm. We therefore propose an enhanced algorithm which consistently respects engines' limitations to improve the resulting speed trajectories. This allows for further improvement of the optimisation results.



Speed-distance and time-distance plot. Thanks to the speed recommendation sent to the driver, he or she is able to save time (green case).