SORTEDmobility

Self-Organized Rail Traffic for the Evolution of Decentralized MOBILITY

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SORTEDMOBILITY proposes a holistic approach for self-organizing management of public transport operations in urban and interurban areas, specifically focusing on rail transport as a mobility backbone.

The first 18 months of the project have passed. Much progress has been done in many directions, all concurring with defining a novel approach to train traffic management. Here is what's happening these days:

Mobility Demand Modeling

Within the SORTEDMOBILITY project, we consider two main demand modeling threads. The first develops models at the **individual traveler** level of daily activity and mobility decisions under current and highly dynamic/self-organized rail operations for integration with the simulation framework. These models are currently being developed to provide demand-sensitive forecasts for the evaluation of alternative self-organizing concepts under the SimMobility framework (https://github.com/smart-fm/simmobility-prod). The second research thread develops online aggregated and short-term **demand prediction** models for origin-destination matrices based on historical and simulated data to be integrated directly within the self-organizing traffic management algorithms. In this thread, an overall model framework has now been developed and an integration within the self-organizing algorithms has also been proposed aiming at achieving demand-sensitive predictive optimization. Both threads are led by researchers from the Machine Learning for Smart Mobility (MLSM) group at the Technical University of Denmark in collaboration with all the other consortium partners. Its initial formulations and estimations were presented at the Traffikdage 2022 conference in last August, Aalborg, Denmark (https://journals.aau.dk/index.php/td).

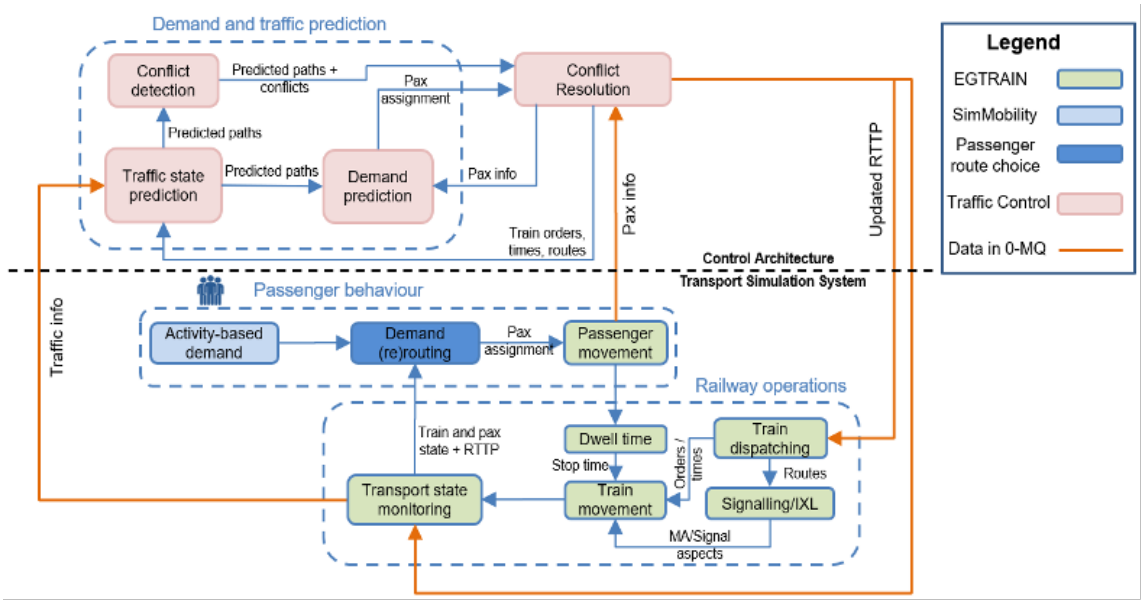
The Copenhagen case study is used as a laboratory for model design and estimation, and datasets from Banedanmark (infrastructure and operational data), Rejsekort Corporate (public transport, including rail smart-card data) and TU (household travel survey) are used in model estimation. Progress was also achieved for the demand generation for the French case study, based on information provided by the Société Nationale des Chemins de fer Français – SNCF.

Algorithms for Self-Organizing Railway Operations

The algorithms for self-organising railway operations will allow trains to autonomously solve possible conflicts and adapt to a changing demand, minimising delays and maximising user satisfaction. The **architecture** for self-organised traffic management is described in Deliverable 3.1 (https://www.sortedmobility.eu/download/). The first version of the defined software modules have been developed. In the SORTEDMOBILITY approach, trains will individually make **hypotheses** about how traffic should be organised, and then share such information to reach an agreement with neighbouring trains. The algorithm that leads a group of train to reach **consensus** on the traffic management is being developed taking inspiration from voter models, which dictate how to reach a global agreement from local interactions. The specificity of the problem resides in the need to find individual plans that are compatible with the plans of all other trains in the network. This research is led by the Institute of Cognitive Sciences and Technologies (ISTC) of CNR and includes the participation of all academic partners, and of researchers from Université Gustave Eiffel in particular.

The first presentation on the self-organization algorithm will be given during the ROADEF 2023 conference in February. We will report on a proof of concept showing the applicability of the algorithm.

Simulation platform for the assessment of self-organising railway operations



For testing and assessment of the self-organising traffic algorithms, an integrated and flexible simulation environment is developed to capture effects on rail traffic and the travel demand. To this purpose, a web-based software architecture is implemented to dynamically interface the **microscopic traffic simulator** EGTRAIN with the self-organising traffic management algorithms and the travel demand prediction models. Details of those interfaces are available in a public deliverable (D4.1) which can be downloaded at the link: https://www.sortedmobility.eu/download/.

A microscopic simulation model of an Italian and a French case studies have been already implemented in the EGTRAIN simulator while a third case from Denmark is close to completion. Currently a microscopic passenger flow model is also being embedded in the EGTRAIN simulator for a realistic estimation of train dwell times in function of the passengers at the platforms and onboard of the trains.

Such activities are led by researchers from the Digital Rail Traffic Lab (DRTLab) of Delft University of Technology and includes the participation of all academic partners.

Case Studies and Impact Assessment

The assessment of impact from self-organised train operations and demand modeling is performed based on the defined KPIs. To this end, three relevant case studies have been identified. This activity is led by researchers from the Université Gustave Eiffel and includes the participation of all partners.

Three case studies with very different characteristics have been chosen for this assessment: the **Copenhagen** urban network in Denmark, with its star-shaped infrastructure and its high frequency service; the **Guingamp-Paimpol** line in France, with its low demand and its critical role of mobility enabler in rural areas; the **Pioltello-Rovato** line in Italy, with its dense mixed traffic, including both freight and passenger (conventional and high speed) services. Moreover, Enhanced infrastructure layouts are considered for Copenhagen and Guingamp-Paimpol to further challenge self-organization. To effectively test the integration of self-organization algorithms and demand prediction models, we consider a "Copenhagen mini" case, built around Hellerup station, which is the busiest node in the network.

The SORTEDMOBILITY team

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Follow us to keep an eye on this work!

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