# SORTEDmobility

## Self-Organized Rail Traffic for the Evolution of Decentralized MOBILITY

June 2022

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 year of the project has just finished, and much progress has been done in many directions, all concurring to defining a novel approach to train traffic management. Here is what's happening these days:

### Operational Principles and KPIs for Self-Organizing Railway Operations

One of the major goals of the project is to define the operational principles which will drive self-organizing railway operations, and the KPIs appropriate for the system assessment. These definitions are now available in Deliverable 1.1 (https://www.sortedmobility.eu/download/). They are the results of a thorough literature review, of detailed interviews with experts from Infrastructure Managers (IMs), and of fruitful discussions held during a dedicated workshop (https://www.sortedmobility.eu/events/).

### Mobility Demand Modeling

Within the SORTEDMOBILITY project, we consider two main 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. These models are currently being developed and integrated within a railway simulation framework to provide demand-sensitive forecasts for the evaluation of alternative self-organizing concepts. 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 potential extensions have been explored. These activities are led by researchers from the Machine Learning for Smart Mobility (MLSM) group at DTU Transport division and include the participation of all consortium partners. In addition, and as part of the second research thread, the research group at DTU has been in contact with researchers from KTH in Stockholm exchanging ideas about current and future work.

The Copenhagen case study is used as a laboratory for model design and estimation, and datasets from Banedanmark (infrastructure and operational data) and Rejsekort Corporate (observed demand data) have already been collected and are being used in model exploration. Two other case studies in Italy and France will also be considered and context-specific modelling features are being defined together with the local partners.

### 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 has been defined, and it is described in Deliverable 3.1 (https://www.sortedmobility.eu/download/). The first software modules are currently being 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.

To evaluate the overall compatibility, we are developing a software module that merges the solutions proposed by every train into a single global solution. This merging process moves from three-way merge processes used in version control of distributed content development (e.g., git) and applies a logic that is specific to the semantics of train traffic plans. 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.

### Simulation platform for the assessment of self-organising railway operations

For testing and assessment of the self-organised algorithms, an integrated and flexible software environment must be defined and developed. It will provide a traffic simulation model considering interactions with the travel demand. To this purpose, a web-based software data interface will be developed to enable real-time communication among the self-organising traffic management algorithms, the travel demand prediction models and the microscopic traffic simulator EGTRAIN, which is here considered as a virtual emulator of realistic railway operations. This activity is led by researchers from the Digital Rail Traffic Lab (DRTLab) of Delft University of Technology and includes the participation of all academic partners.

The EGTRAIN simulator has been so far initialised with real data from two case studies. Ongoing activities are focused on embedding a microscopic passenger flow model in EGTRAIN to accurately assess train dwell times depending on the number of passengers on the platforms and onboard of the trains. Moreover, software interfaces are being set up to allow dynamic interactions with the individual traveler-level demand model and the self-organising traffic management algorithms.


## 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. Enhanced infrastructure layouts are considered for Copenhagen and Guingamp-Paimpol to further challenge self-organization. All details of these case studies are available in Deliverable 5.1 (https://www.sortedmobility.eu/download/). Data modeling is going to be completed during summer.

## *The SORTEDMOBILITY team*

SORTEDMOBILITY is funded under the Horizon 2020 ERA-NET Cofund scheme, under grant agreement No 875022. Find out all about the project on www.sortedmobility.eu.

Follow us to keep an eye on this work!

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