• **MuTAS : Multimodal Transit for Accessibility and Sustainability**. Projet ANR JCJC (48 months), coordonné par Andrea ARALDO (Telecom SudParis), démarrera au 1er mars 2022.

In collaboration with: CY Cergy Paris Université, Tech. Univ. Denmark, Vedecom, Min. Trans. Écologique / ENTPE Univ. G.Eiffel, Mines St-Étienne, Massachusetts Inst. Of Tech (MIT), Technical University of Munich (TUM), Free Univ. Brussels, Hasselt Univ. (Belgium)

Proposal's context, positioning and objective(s)

The role of Fixed Route Transit (FRT) is currently challenged by the advent of Mobility on Demand (MoD) services and by exceptional circumstances, e.g., the pandemic. To take on such challenges toward societal and environmental gains, future transit needs to go beyond its traditional rigidity. In this project we propose to integrate MoD and FRT into a unique smart multimodal service. This requires a deep re-design of transit, for which no systematic methods exist up to now. The goal of MuTAS (Latin form of "to mutate") is to devise a general methodology to guide such a re-design, combining Network Science, Tranportation Engineering and Artificial Intelligence (AI). The re-design of transit aims to increase geographical equity in transportation accessibility[9], which measures how easy it is, starting from a certain location, to reach all the others. By doing so, we aim to overcome the inherent poorer Quality of Service (QoS) of transit in the outskirts with respect to city centers, that currently forces suburban population to rely on private cars, thus increasing the environmental impact of transportation. It is believed that it is infeasible (and even undesirable) to pursue transit accessibility equity between the outskirts and the center, due to the high cost to do so[44]. While this is true under current current transit schemes, which only rely on FRT, in MuTAS, we will show that the integration of MoD allows to approach such transit accessibility equity goals. We will also show that, by improving transit accessibility equity, we can reduce private-car-dependency of the outskirts, thus inducing modal shift from private cars to transit, with the consequent reduction of congestion, pollution and energy consumption. To achieve the above objectives, we first construct high level models of transit based on open data available for different cities. We than propose a novel AI-based optimization methodology on such models, which is able to jointly decide in which sub-areas to deploy MoD, along with the size of the fleet, and how to optimally fix FRT schedules and routes. The set of this decisions defines a transit layout. We finally validate the quality of the optimized transit layout in an activity-based simulation of Île de France.
We emphasize that the transit design of MuTAS is adaptive, as the aforementioned decision variables can vary over the time to adapt to the daily demand pattern. Although MuTAS mainly focus on "normal" operational condition, we believe that the adaptivity of our design can be precious also to cope with unexpected changes of demand or transit capacity, as the ones the entire world has experienced during the pandemic. For instance, if the demand reduces due to mobility restrictions, MuTAS optimization would decide which lines or stops to suppress and where to replace them with MoD. Observe that it is easier to enforce social distancing into MoD cars than transit, by means of physical separators (glass or plastic) as already partially adopted by private companies like Uber and Lyft.
The methodology of MuTAS will be materialized in an open source software framework, meant to be used by researchers, practitioners and planners, which will compute and show the modifications required to current transit design toward future generation multi-modal transit.
Despite we recognize the scope of the project is ambitious, we firmly believe we will achieve solid results. Indeed, we will not create all the methodological and software tools from scratch, but we will heavily re-use and combine some already built by the scientific community in the last decades, in particular regarding network engineering, artificial intelligence and transportation science. Examples

of software we plan to reuse is listed in Table 1. MuTAS could not be feasible without that previous effort. For this reason, in addition to the methodological novelty it brings, we like to think MuTAS as a showcase of the benefits of open science, where researchers share methods, datasets and code that enable other researchers to achieve more ambitious results.