

Connected and Autonomous Shuttles for Optimal Passenger Transportation and Last-Mile Parcel Delivery

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PROBLEM

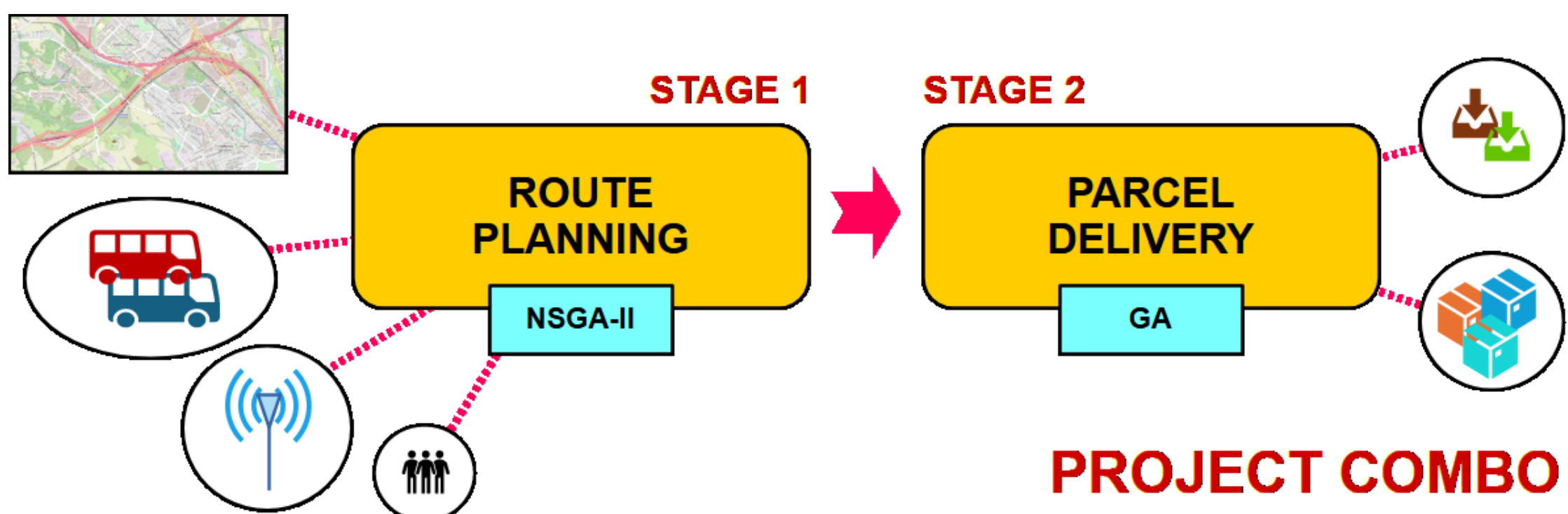
- ❖ Demand of shared mobility services for short trips
- ❖ Need of a cost saving alternative to public transport
- ❖ Last-Mile parcel delivery has a huge impact on urban traffic congestion and the environment
- ❖ Failed deliveries are one of the most important challenges that transport companies face
- ❖ Increase in CO₂ emissions produced by multiple delivery attempts

PROPOSAL

Use of connected and automated shuttles (CAS) as a transformative approach to public transportation as well as to deliver parcels to pick-up/drop-off (PUDO) points located close to bus stops. By doing so, we complement both, the existing public transportation service and the last-mile parcel delivery service.

In the project COMBO we address this problem by using a multi-objective optimisation algorithm (NSGA-II) for calculating shuttle routes while taking into account passenger satisfaction and shuttle 5G connectivity.

Once a route set is selected, we calculate the optimal parcel delivery plan by using a Genetic Algorithm (GA), taking into account the existing parcel batch, shuttle routes, and the onboard empty space between stops.



CONNECTED AND AUTOMATED SHUTTLES IN PUBLIC TRANSPORTATION

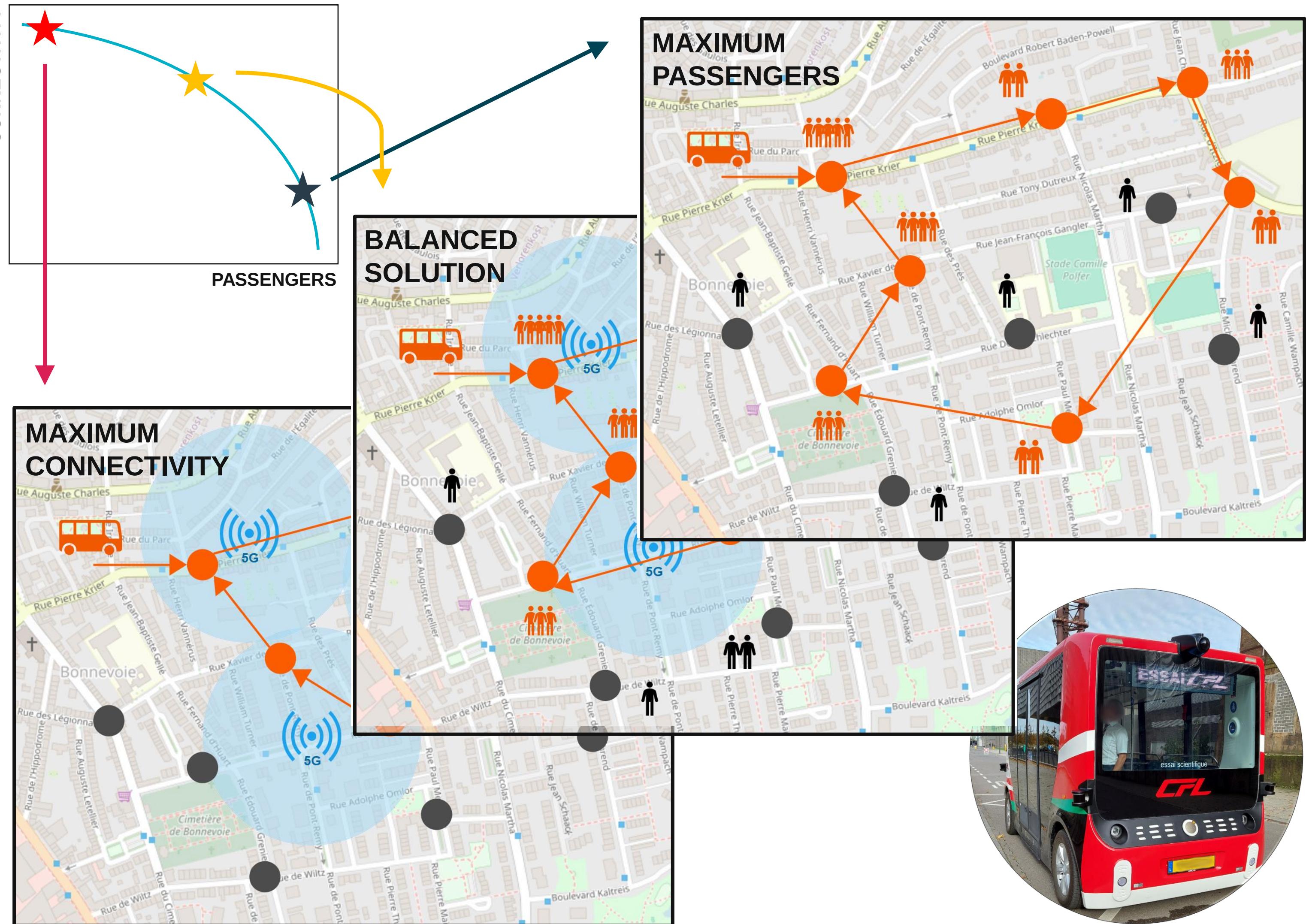
Our proposal uses the actual city traffic layout, the existing 5G infrastructure, and a reliable public transportation demand model. It is supported by:

- ❖ Transmission model using standardised wireless channel models (3GPP)
- ❖ Passenger demand matrix calculated from historical data

The use of the NSGA-II algorithm produces a set of optimal, non-dominated solutions which:

- ❖ Maximise the network's quality of service
- ❖ Maximise the number of served users

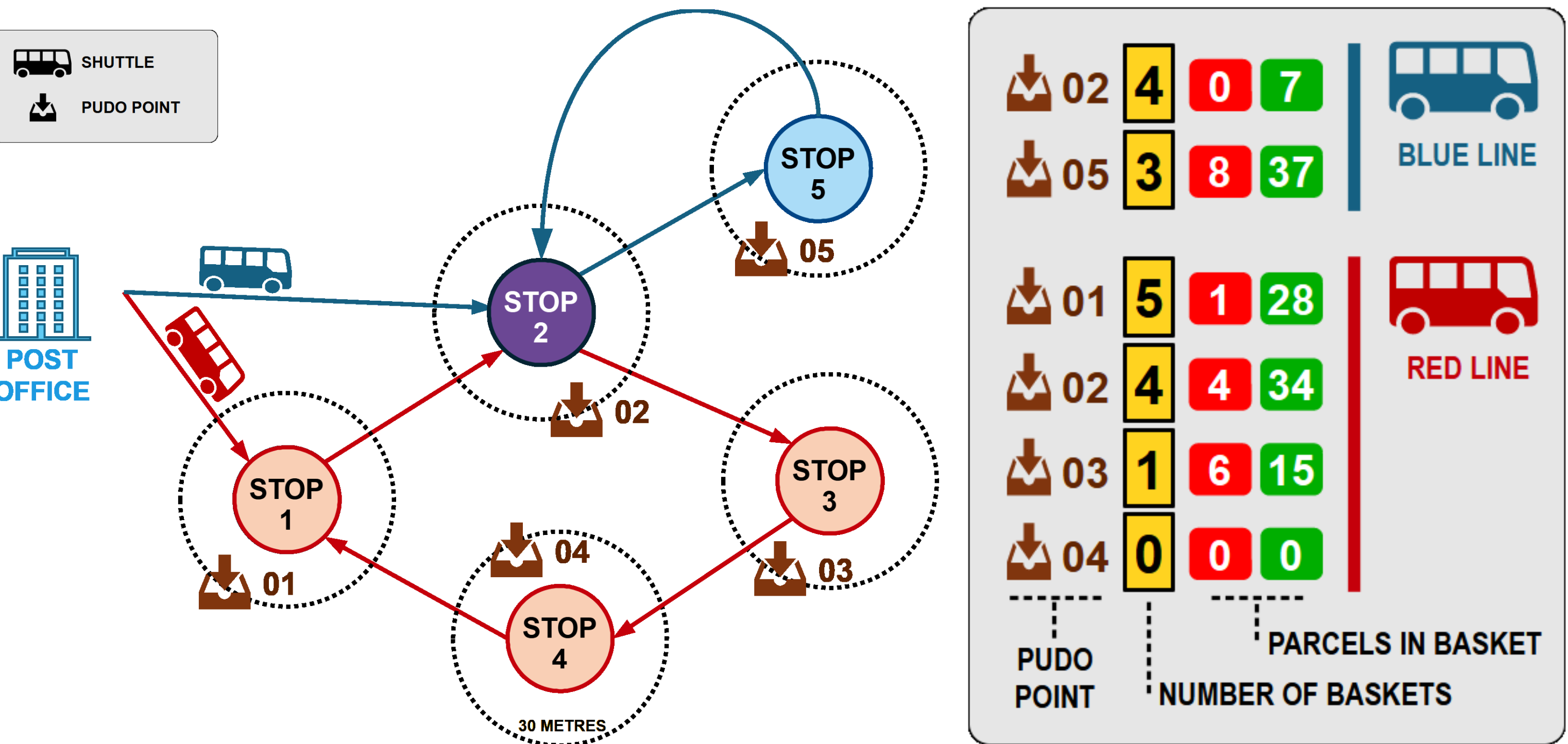
Then, an expert can decide which optimal solution fits better the company's needs.



LAST-MILE PARCEL DELIVERY

We propose to use the onboard empty space on the shuttles to carry mail baskets, optimally filled with parcels, without penalising the passenger service.

These mail baskets are destined to PUDO stations close to the existing shuttle stops (calculated on the previous stage). The assignation of baskets, their contents (parcels have a different size), and how shared stops are served, are all part of the solution calculated by the proposed GA.



RESULTS

From our experiments on 360 testing scenarios, comprising up to 5 shuttles and up to 20,000 parcels (far more than in a typical day), we have achieved the following results:

SHUTTLES	1	2	3	4	5
PARCELS DELIVERED	21.5%	25.4%	29.7%	32.1%	35.8%