

Analysis and Evaluation of the Nice-Monaco Veolia bus system

Abstract

Workers and tourists generate important traffic between Nice and Monaco. Veolia Transport offers a bus service to transfer people. There are **three different ways to connect Nice and Monaco by bus** : a highway (line 100X), a suburban road running by the Sea with high bus frequencies (line 100) and a suburban road in between (line 112). The southern is very congested because it's an attractive way (due to its high frequency) for workers who live between Nice and Monaco and it's the most beautiful road for tourist. So, buses are full and travel time is heterogeneous during the peak hour. Sometimes people have to wait for two or three buses before being able to take one. The objectives of this project are to **identify the causes of congestion** and **propose alternatives for a better distribution** in space and/or time of passengers to their destinations. And hence, improve the level of service, decrease operational costs, increase passenger satisfaction and possibly attract induced demand.



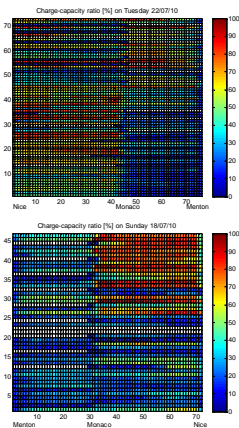
Problematic

Charge-capacity ratio :

The charge-capacity ratio graphs show how full buses are during one day. Each line stands for one bus (low bus numbers stand for morning buses, and so on). Basically, **the redder the bus, the fuller it is**.

The graphs were done for 9 days of data (3 in July 2010, 3 in September 2010 and 3 in December 2010) and in both directions (Menton-Nice and Nice-Menton).

As seen on the right, **the most problematic ones were in July** (this is due to the fact that there are both **workers and tourists** travelling in summer) : a bus which is full (even only up to 90%) means that passengers have to stand in the bus. One can also see a **commuter trend** : Nice to Monaco in the morning, Monaco to Nice in the afternoon.

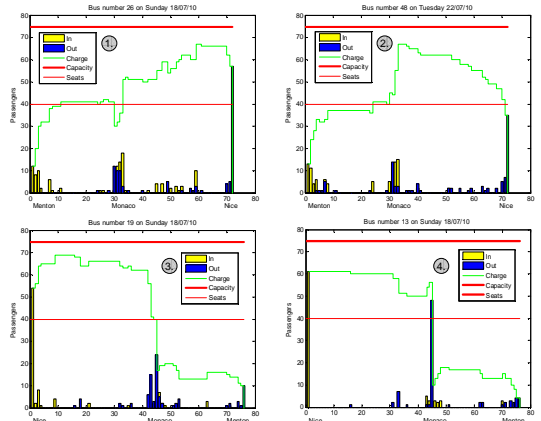


Passenger charge patterns :

After analysis of each line of the charge-capacity graphs, four different passenger charge patterns were identified. It was **statistically impossible** (because only 9 days of data available) to **detect a correlation** between these patterns and time of day, bus direction or seasonality. However, these **patterns are very general and repetitive** and therefore call for general solution approaches (see below).

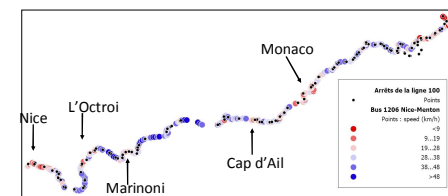
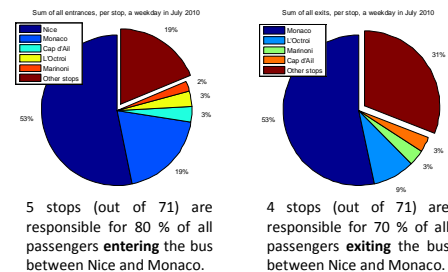
The four identified patterns are the following :

1. **Spread-out entrances** (bus charge regularly rises between Monaco and Nice).
2. **Spread-out exits** (bus charge regularly decreases between Monaco and Nice).
3. **Stable bus charge**.
4. **Commuters** (nearly no passenger exchange between Nice and Monaco).



Data investigation

Different « **specific** » stops (i.e. where many passengers get in/out during one day) were identified by summing all entrances and exits of passengers at every stop for each of the nine days. The following stops are relevant for all days of data : Nice, Monaco, l'Octroi, Marinoni and Cap d'Ail.



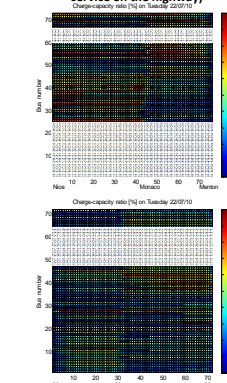
From GPS data, bus speeds were computed. This spatial representation of specific stops shows the same results as the passenger charge analysis : **slow buses = high passenger exchange at bus stop**.

Propositions of solutions

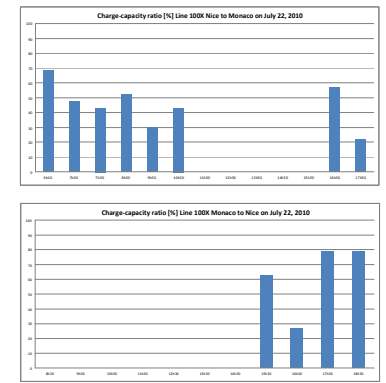
From the charge and specific stop patterns, different solutions are possible :

- **Reassign commuters** (i.e. passenger charge pattern 4) to the 100X Express line on the highway.
- Create a **new line** which stops only at the identified **specific stops**, but still follows the sea road.
- **Halve the line 100** (Nice – Monaco and Monaco – Menton).
- Do not interrupt the line 100X during the afternoon or the weekends (see below : when there is no service on the highway, the buses on the line 100 are much more crowded).

Line 100 (white mask when service on the highway)



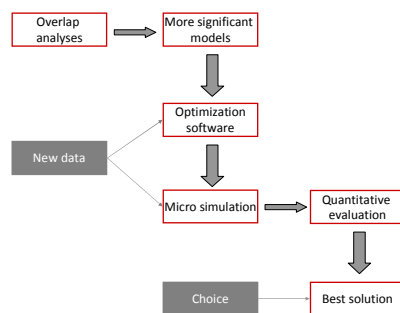
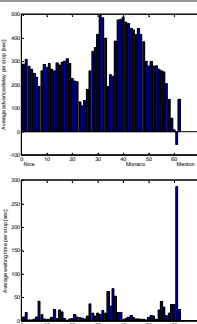
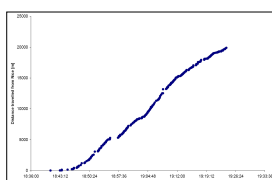
Line 100X



Next steps

Further statistical analysis of new data :

- **Time-space** diagrams (on different lines to estimate average travel times between Nice and Monaco and determine patterns specific to the time of day)
- Average **delay**, **waiting time** and **headway** per stop (in order to determine most problematic stops)
- Average **bus speed** between stops



The final goal is to overlap all analyses of data for different seasons and days to find significant models and create an optimization software.

This software will treat and analyze new future data from Veolia to put in a micro-simulation which will assist in finding the best solution.