# Multi-objective dynamic geo-fencing for metropolitan transportation networks

NIRVANA PECORARI

Department of Transport and Planning
Faculty of Civil Engineering and Geosciences
Technical University of Delft, Delft, The Netherlands

## ABSTRACT

In the current historical period, increasingly dense urbanisation is motivating a redesign of public space, in order to foster liveability and sustainability. In order to meet these desirable objectives, a careful approach must be adopted so to maintain, if not improve, the Quality of Life standards (liveability, air quality, noise…) while maintaining accessibility through well-managed transportation services. To date, perimeter control represents a strategy to address problems of congestion, pollutant emissions and safety within a static (or fixed) area by monitoring the entry flow at the perimeter. For instance, a central metropolitan area is delimited, and access to it is regulated through a scheme with fixed time intervals, applied to a specific target of vehicles. Examples of such perimeter control schemes are those operating in London (s. 2003), Stockholm (s. 2007) and Milan (s. 2008), all inspired by the ERP used in Singapore (s. 1998).

The constraint concerning the rigid definition of the critical areas prevents the network control paradigm to swiftly respond to the time-and-space-varying nature of KPIs. The approach that we would like to outline with this research is based on virtual zoning (geo-fencing[1] ), able to vary in number, shape and size over time (dynamic). In other words, we aim to develop, study and evaluate road network supply management approaches based on a *real-time variable perimeter* surrounding geographical areas which should be 'protected' from traffic, e.g. in response to heightened pollutant emissions, traffic congestion or incidents, vulnerable infrastructure.

In the first part of our study we aim to investigate to what extent dynamic-*responsive* geo-fencing better than static geo-fencing in handling both typical and atypical network conditions. A threshold value or critical value must be established for each KPI of interest; when this value is reached - or in anticipation of it being reached - in a specific geographical zone at time t, the *same* zone is defined as critical at time t, hence the adjective "responsive". Further, as generalization, we aim to investigate to what extent dynamic-*anticipatory* geo-fencing is better than static geo-fencing in handling both typical and critical network conditions, e.g. car accidents. Anticipatory traffic control policies consist in a subset of coordinated traffic control policies that use a model to forecast future network circumstances as well as explicitly consider user route choice reactions.

To do this, we will collect the data concerning the KPIs of interest from available sources (e.g. NDW), process them through cleansing, data fusion techniques, and produce a

[1] The use of a “geo-fence” is called “geo-fencing”. A “geo-fence” is a virtual perimeter for a real-world geographic area. Terms like “perimeter” or “cordon” are intended as synonymous of “geo-fence” in the current document.

two-dimensional map resulting from the convolution of the heat-maps associated with each for the same area and in the same time interval. Next, we will draw the perimeter of the zone(s) to control through an optimization process. Lastly, we will simulate the rerouting of the vehicles approaching to the zone(s) to control exploiting optimal route guidance through dynamic avoidance maps – broadcasted publicly through the traditional roadside system and privately through an in-car system. The approach`s evaluation will follow.

**Key words**: sustainability, perimeter control, dynamic geo-fencing, responsive cordon, anticipatory control, dynamic avoidance maps.

*N. Pecorari (1997) is currently a first year PhD candidate at the Department of Transport & Planning of Delft University of Technology. She works under the supervision of Dr. Ir. M. Rinaldi, Prof.dr. L. Leclercq and Prof.dr.ir. S.P. Hoogendoorn. N. Pecorari holds a MSc in Physics from the University of Ferrara (Italy), and a BSc in Physics from University of Bologna (Italy). She is affiliated with AIM Lab, AMS and University Gustave Eiffel.*