Abstract of the Doctoral Thesis in

INNOVATIVE TRAFFIC FLOW MODELLING TOOLS FOR ADVANCED URBAN TRAFFIC CONTROL

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The current evolution of vehicles with the development of new on-board technologies, allow for increasingly more connected vehicles, which also enables the development of more intelligent and autonomous vehicles. The result of including connected and autonomous vehicles on the network has the potential to achieve several benefits, as better values of traffic flow and reduce congested areas or congestion in general, a more sustainable mobility from a more efficient driving behaviour, safer trips, increase accessibility to transport services, exchange of information for a better traffic prediction, etc.

The use of these technologies does not guarantee reliable and accurate results unless they are enabled by specific models behind them. To do so, it is necessary to study the vehicular flow in the presence of CAVs. This arises two challenges:

- a methodological challenge, to have a vehicular flow model that allows us to implement this new technology in a mixed context of connected and unconnected vehicles.
- an operational challenge, in which by combining the data collected from the connected vehicles and the traffic flow model, it is possible to adopt an advanced control strategy, and therefore achieve the benefits of having CAVs in the network in an urban context.

The objectives of this thesis are:

- Obtain an urban network management through the combination of a network traffic control strategy and link metering, optimising green times, offsets and stage sequences on an on-line network control and link control (Chapter 4.1)
- Develop "energy-saving" control strategies considering EVs energy consumption patterns, to support the development of a unified network traffic control strategies aiming at minimising also EVs energy consumption (Chapter 4.2).
- Integrate a traffic control strategy with the Single-Segment Green Light Optimal Speed Advisory (S-GLOSA), optimizing the speed of connected and autonomous vehicles (Chapter 4.3).
- Develop a traffic flow model capable of simulating a mixed context of connected and unconnected vehicles, combining a macroscopic model along the arc and then a microscopic model at the nodes, concentrating there all the computational and analytical efforts, with a reduced number of parameters to calibrate (Chapter 5.1 and 5.2)
- Integrate such model with an advanced control strategy for the optimisation of traffic light plans, with the capability to work on real time, receiving data acquired through sensors, cameras, radar, probe vehicles, etc., to obtain a more accurate and reliable prediction (Chapter 5.2)
- Compare this traffic flow model with macroscopic and microscopic benchmark models (Chapter 5.3)

The dissertation focuses on the developed hybrid traffic flow model (H – CTMCA), obtained by combining a macroscopic approach to model links with a microscopic approach to model nodes. To this end, two traffic flow models were adopted: a simplified microscopic Cellular Automata model (CA), and a macroscopic Cell Transmission Model (CTM). The proposed hybrid model proved suitable for analysing traffic flow phenomena and can also be adopted for traffic control in both cases: in the context of multi objective optimisation (for instance based on surrogate indicators) and with the presence of connected vehicles.