

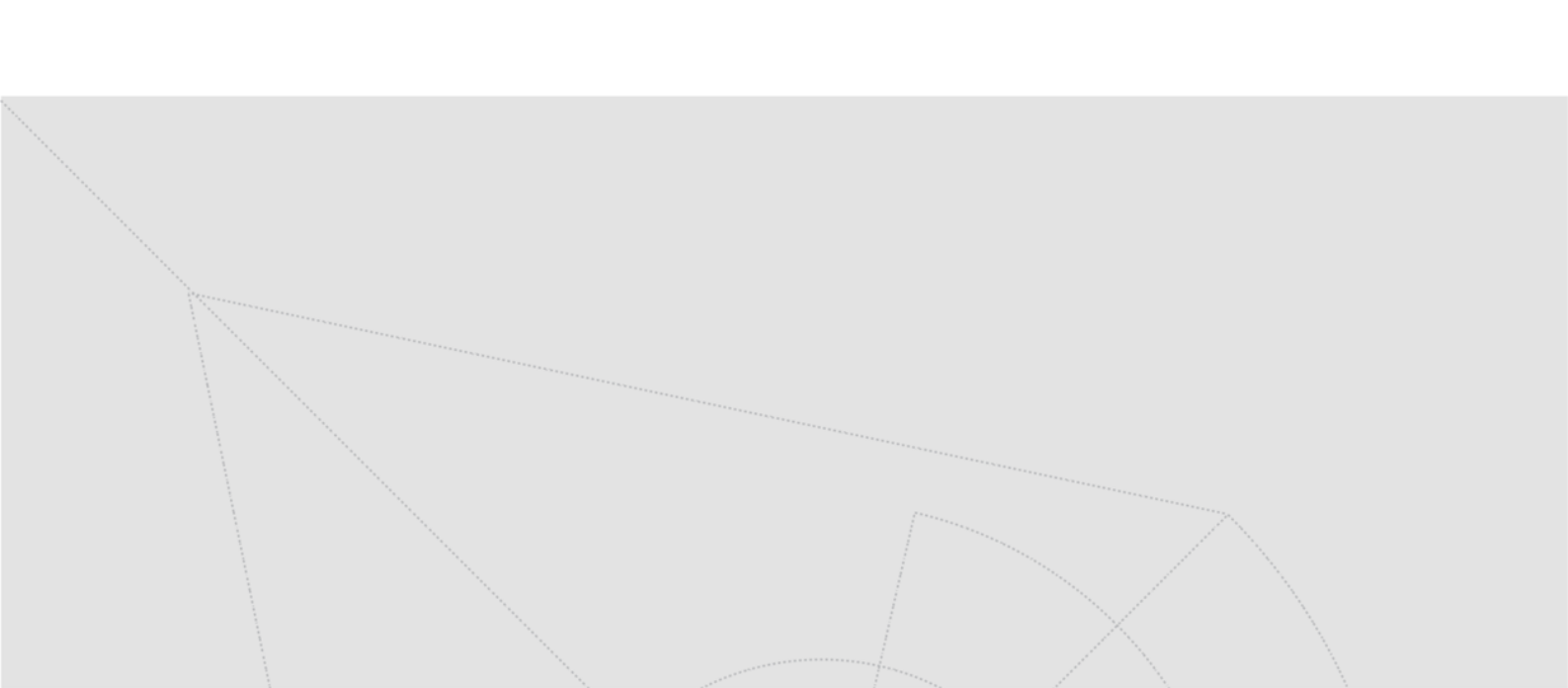
PROJECT / Semáforos Virtuais

VTL

Main Objective:

Urban transportation is one of the grand challenges of our times. Car journeys are by far the main player in this transportation, comprising 72% of all passenger kilometers in the European Union (EU) [1]. Traffic congestion on the road is thus a common reality of the major EU cities, and has been estimated to cost as much as 1% of the GDP. In its present form, the use of Traffic Lights (TL) to control and regulate this road traffic has proven to be very costly and inadequate in terms of scalability. Leveraging the new vehicle-to-vehicle (V2V) communication capability of modern cars we propose to design and validate an alternative scheme of urban traffic control that envisions TL as in-vehicle virtual signs, enabling ubiquity of signalized intersections, and defining the synchronization of light phases, cycle durations and green splits based on distributed and self-organization techniques that govern a vehicular ad hoc network (VANET).

The non-scalability of TL, and in particular the non-scalability of an adaptive and intelligent citywide system of TL (a recent survey reports that 70-90% of the deployed TL are non-adaptive [2]) is a key aspect that we shall address through the alternative approach proposed in this project. Even New York City only has 10,800 of its 45,000 intersections managed by TL [3]. In other cities this percentage is typically smaller. In addition to traffic flow improvement, TL have also a significant impact on road safety, as studies report a 33% decrease in vehicle crashes at intersections that have been equipped with traffic signals [4].

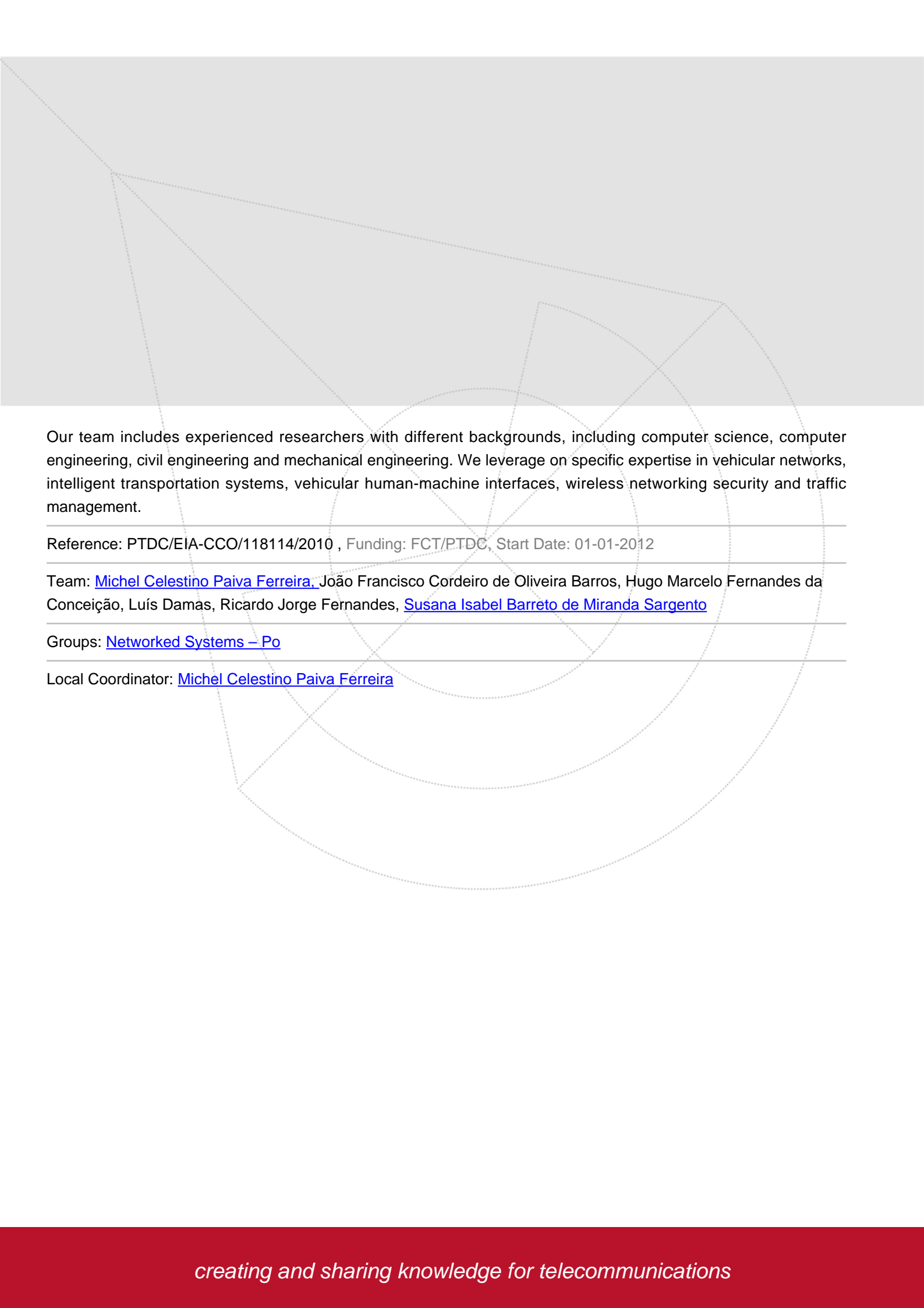


Our approach in this project will take advantage of the mandatory adoption by the automotive industry of the Wireless Access for Vehicular Environments (WAVE) protocol, and the ability of vehicles to communicate with each other, thus creating a distributed and highly reliable system of in-vehicle virtual traffic lights (VTL). Our preliminary simulations of this self-organizing traffic paradigm show a potential to increase the average flow rates substantially (up to 60%, compared with a city-level physical TL system [5]), in addition to rendering traffic control and management more ubiquitous and cost-effective. Our basic idea is relatively simple: use the core characteristics of VANET, namely periodic beaconing, location tables and appropriate transport and MAC protocols to perceive crossing conflicts and elect a leading vehicle that works as a temporary virtual infrastructure, stopping under a virtual red light at the entrance of the intersection and broadcasting virtual traffic light messages that are listened by the vehicles approaching the intersection. Local optimization of cycle duration, phase layout and green splits are computed based on the number of vehicles in each approach. City-level optimization of traffic flow can resort to the synchronization of leaders in adjacent intersections or even to a traffic information system that also leverages on VANET communication. Devices on each vehicle interpret the VTL messages and display the respective color to the driver. We envision the computing, communication and display device to be possible to retrofit on the existing car park, and the project will produce such devices. By providing unequivocal evidence of the envisioned approach on the mitigation of traffic congestion, its economical and environmental impact, and increased road safety, the project intends to pave the way for the adoption of EU legislation towards the equipping of all vehicles with VTL.

Our project is a natural follow-up of the DRIVE-IN (Distributed Routing and Infotainment through Vehicular Inter-Networking) project, funded by the Portuguese Science and Technology Foundation and involving an international partnership with Carnegie Mellon University in the US. DRIVE-IN has been designing VANET communication protocols and developing high-scale traffic models and simulators that will support the design and validation of the in-vehicle VTL system. DRIVE-IN has also deployed a prototype VANET in the city of Porto, resorting to 450 taxis where carPCs with windshield displays are installed, together with 802.11p wifi cards for V2V and vehicle-to-infrastructure (V2I) communication. This test-bed constitutes a major asset for the research herein proposed and shall be used for proof-of-concept field experiments in closed areas of the city.

The project is structured in the following four main tasks:

- 1 – Design of the VTL communication protocol and distributed optimization of traffic flow.
- 2 - Security and reliability of the VTL system.
- 3 - Human-machine interface of the VTL system and usability evaluation.
- 4 - Hardware design for retrofitting and field trial experiments.



Our team includes experienced researchers with different backgrounds, including computer science, computer engineering, civil engineering and mechanical engineering. We leverage on specific expertise in vehicular networks, intelligent transportation systems, vehicular human-machine interfaces, wireless networking security and traffic management.

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