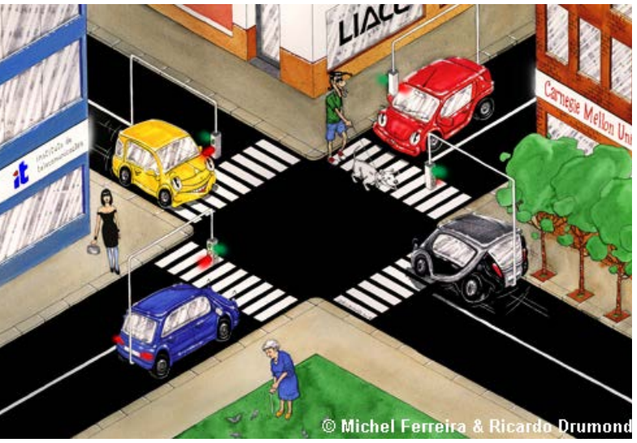
Virtual Traffic Lights

The VTL project designed and validated communication, security and human interaction aspects of a novel urban traffic control scheme that replaces current traffic lights by in-vehicle virtual signs resorting to vehicular communications and distributed computing. The proposed system is enabled by ubiquitous, distributed and self-organized control of signalized intersections.



PROJECT WEBPAGE URL
http://www.virtualtrafficlights.com/

Main Project Team	
Michel Celestino Paiva Ferreira	**NS-Po**
Susana Isabel Barreto de Miranda Sargento	NAP-Av
Joaquim Gabriel Magalhães Mendes	LAETA
João Francisco Cordeiro de Oliveira Barros	NS-Po
Luís Manuel Martins Damas	Geolink Lda.
Rosaldo José Fernandes Rossetti	LIACC
José Pedro Maia Pimentel Tavares	CITTA
Pedro Miranda de Andrade de Albuquerque d'Orey	NS-Po
Hugo Marcelo Fernandes da Conceição	NS-Po
Cristina Olaverri Monreal	IT-Po
André Amorim de Faria Cardote	NAP-Av
Traian Emanuel Abrudan	IT-Po
Luís Carlos da Silva Coelho	IT-Av
Fausto José Canhoto de Paiva Vieira	IT-Po
Ricardo Jorge Fernandes	IT-Po
Pedro Emanuel Rodrigues Gomes	IT-Po
Funding Agencies	
FCT - Fundação para a Ciência e a Tecnologia	**198,731€**
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Indicators	
Journal Papers	10
Conference Papers	30
Patents	2
Concluded PhD	4
Concluded MSc	5

Two Main Publications

H. Conceição, M. Ferreira, P. Steenkiste, **Virtual Traffic Lights in Partial Deployment Scenarios**, IEEE Intelligent Vehicles SympC. Olaverri , P. Gomes, R. Fernandes, F. V. Vieira, M. Ferreira, The See-Through System: A VANET-Enabled Assistant for Overtaking Maneuvers, IEEE Intelligent Vehicles Symposium - IV, San Diego, United States, Vol. NA, pp. 123 - 128, June, 2010

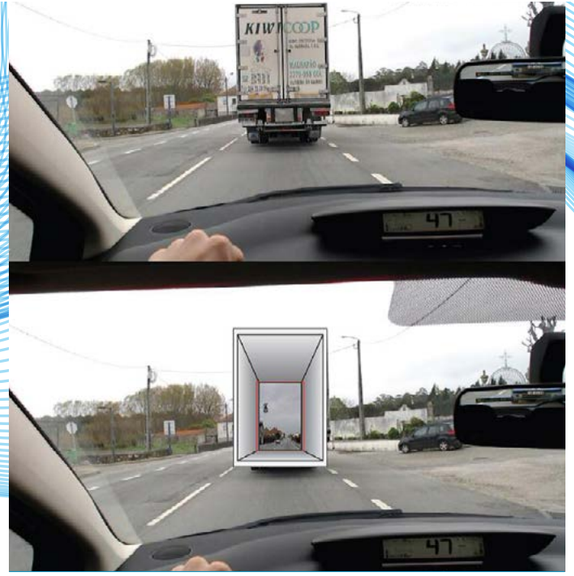

Fig. 1 See-through system.

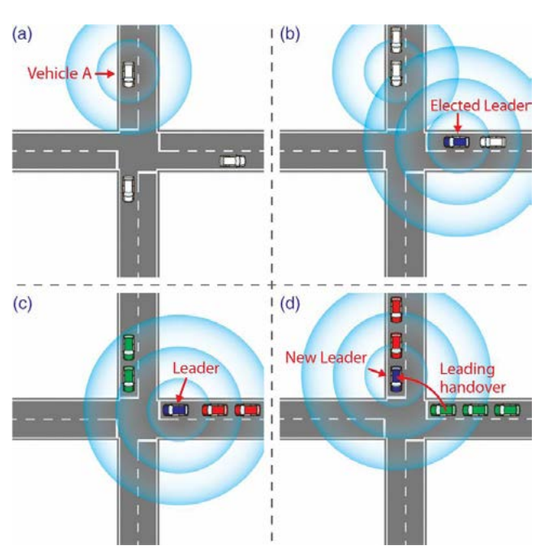

Fig. 2 Virtual traffic lights operation.

GENERAL MOTIVATION AND OBJECTIVES

Road traffic congestion is a common reality of major cities throughout the world, and has been estimated to cost as much as 1% of the GDP in the EU. The VTL project had as main objective the design, development and large-scale assessment of several critical components of the self-organized and distributed intersection control enabled by vehicular networks, namely: design of the VTL communication protocol and distributed optimization of traffic flow; design of security and reliability mechanisms of the VTL system; design of the Human-machine interface of the VTL system and evaluation of its usability.

CHALLENGE

The in-vehicle virtual traffic lights system faces several challenges that have been addressed in the project. First, traffic control at intersections is a critical operation, as a failure can result in fatal accidents. Thus, reliability and fault-tolerance of intersection control algorithms in asynchronous, broadcast and poorly connected network were fundamental problems that required further research. In addition, security and reliability of communication protocols was critical to any trustworthy implementation of virtual traffic lights. In addition, reliable and smooth interaction of the VTL system with different parties of the transportation system, namely drivers, pedestrians or cyclists, was also considered essential for the full deployment of the system.

WORK DESCRIPTION AND ACHIEVEMENTS

The project involved research structured around four main tasks, namely:

1 - Design of the VTL communication protocol and distributed optimization of traffic flow. In the main task of the project we have focused on the design of the communication protocol, including the distributed optimization that translates into improved traffic flow at a city scale. To support this task, we developed a state-of-the-art VANET simulator tailored to this analysis on a metropolitan-scale. As the VTL technology will not be able to reach all cars instantly, we have also focused on how to solve the issue of functioning under partial penetration scenario.

2 - Security and reliability of the VTL system. Initially, we conducted research to better understand communication patterns between vehicles and vehicles and infrastructure. We also carried out important research to improve the reliability of the DSRC communication, namely by implementing the dual-channel access feature, that enables control messages to be segregated from other services in order to guarantee the dissemination of safety related information (e.g. VTL messages) or by researching packet forwarding strategies and the benefits of deploying roadside infrastructure to improve communications in highway scenarios.

3 - Human-machine interface of the VTL system and usability evaluation. Our research on the use of vehicles as augmented reality platforms extended the scenario of Virtual Traffic Lights. We have used the same principles to design other advanced driver assistance systems, such as an overtaking assistant based on real-time video streaming, or infotainment applications based on virtual billboards.

4 - Hardware design for retrofitting and field trial experiments. In conjunction the Future Cities project, we were able to achieve a testbed for the evaluation of vehicular communications which comprised hundreds of vehicles, distributed between the fleet of taxis and the fleet of buses. A fundamental component of our research in this task was focused on the management of this testbed, and in providing tools to run live experiments on it.

The project has clearly achieved its main goals. The research has produced important knowledge, which was presented at the most important journals and conferences of the area. The patent with the main concept of VTLs has been granted and other submitted. Also significant is the fact that the novel concept of VTLs that we introduced has received attention from different research groups throughout the world, leading to additional contributions in the area.