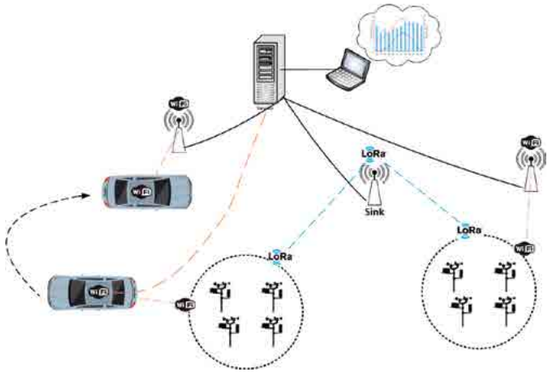
SenseBusNet

Sensing Data and Delay-Tolerant Delivery Over Vehicular Ad-Hoc Networks

The goal of this project was to deliver key networking and data processing modules for a vehicular mesh network capable of retrieving data collected by large numbers of sensor nodes and delivering content through the vehicular network. New mechanisms have been researched to choose the best vehicles to gather and disseminate information through the vehicular network, using the vehicles as data mules.



PROJECT WEBPAGE URL
https://www.it.pt/projects/index/1564

Main Project Team

Susana Sargento	**NAP-Av**
Ana Aguiar	NS-Po
Lucas Guardalben	NAP-Av
Tânia Calçada	NS-Po
André Braga Reis	NAP-Av
Ricardo Dias	NAP-Av
Romeu Monteiro	NAP-Av
Gonçalo pessoa	NAP-Av
Rodrigo Almeida	NAP-Av
Luís Guedes	NAP-Av
Ruben Oliveira	NAP-Av
Daniel Inácio	NAP-Av
Daniel Moura	NS-Po
Pedro Santos	NS-Po
Diogo Guimarães	NS-Po
Carlos Penichet	NS-Po
André Sá	NS-Po
Yunior Luís	NS-Po
Tiago Lourenço	NS-Po
Xavier Araújo	NS-Po

Indicators

Funding	40k €
Journal Papers	2
Conference Papers	11
Concluded PhD	1
Concluded MSc:	7

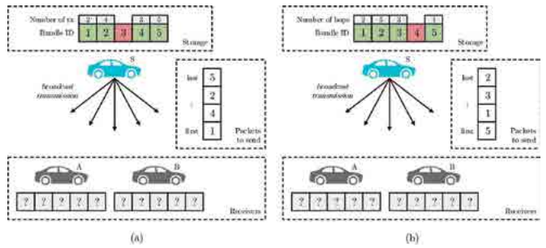


Fig. 1 Content Dissemination.

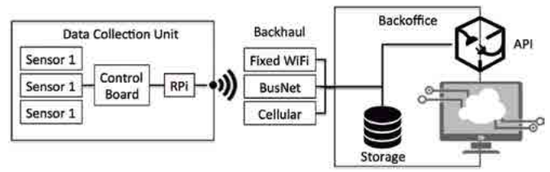


Fig. 2 SenseBusNet Architecture.

Two Main Publications

A.B. Reis, S. Sargento, O. Tonguz, Parked Cars are Excellent Roadside Units, "IEEE Transactions on Intelligent Transportation Systems", Vol. PP, No. 99, pp. 1 - 6, February, 2017.

R. MONTEIRO, S. Sargento, W. V. Viriyasitavat, Ozan Tonguz, A graph structure approach to improving message dissemination in vehicular networks, "Springer Wireless Networks", Vol. 1, No. 1, pp. 1 - 19, April, 2016.

GENERAL MOTIVATION AND OBJECTIVES

This project addresses both theoretical and experimental challenges in mobile sensing with city-scale vehicular mesh networks. In previous projects our research groups at IT in Aveiro and IT in Porto have implemented and built the technology and key networking mechanisms that allow vehicles to form a mesh network and connect to the Internet via fixed stations (or roadside units, RSUs). These vehicles can be used to collect large quantities of geo-referenced data. This data can be collected not only from on-board sensors inside the vehicles, but also from fixed Wi-Fi enabled sensor nodes that are deployed along the vehicles' routes. On the other side, content such as touristic videos can be sent to the vehicles through the vehicular network, which will be the one responsible for the fast delivery of information to the overall set of vehicles.

CHALLENGE

DTN (Delay-Tolerant Networks) routing proposals range from flooding content in the network to solutions that minimize the data delivery time, or to solutions that take into account the social interactions between users and history of contacts. On one hand, in vehicular networks, the interactions have a different nature; on the other hand, vehicular networks have important characteristics that can be used to develop a vehicular-enhanced DTN approach. This approach will embed more intelligence in the selection of the next hops, both for routing and caching of information, such as GPS position, velocity, direction, distance to the receiver, RSU or hotspot, density and history of contacts. Moreover, it is possible to use any interface that is more suitable for the DTN routing approach, not only taking into account the network conditions, interfaces availability and quality, but also the context of information, that is, the nature of information and its urgency. To make the information reach the infrastructure, the approach may distribute the delay-tolerant bundles anycast, among neighboring vehicles to share the load and increase utility of available bandwidth for both vehicles and RSUs, by allowing vehicles to indirectly share each other's bandwidth.

WORK DESCRIPTION AND ACHIEVEMENTS

This project has reached the following achievements:

- Provided lessons learned on the evaluation of the performance of different DTN routing protocols in real world vehicular networks with different degrees of connectivity;
- Designed and deployed new mechanisms for the opportunistic transmission of information through the vehicular network that optimize the gathering delivery times and minimize the overhead in the vehicular network;
- Studied a graph structure approach to improve message dissemination using real life data as well as analytical models, and designed mechanisms to improve the performance of urban vehicular broadcast protocol to reduce the overhead of dissemination while maintaining the message dissemination performance;
- Proposal of a low-cost alternative to a RSU deployment that can operate both independently and in conjunction with existing RSUs. To this end, we introduce a self-organizing network approach that allows parked cars to work as RSUs forming a vehicular support network;
- Proposal of a non-urgent content distribution strategy based on the complete information that is missing in the vehicles, network coding to encode this information and bloom filters to code the information of the content bundles present in the several vehicles;
- Integration of one of the LPWANs technologies, Long Range (LoRa), in a multi-technology data gathering platform;
- Deployed an emulator of the real vehicular DTN approach to test and evaluate new mechanisms in a large-scale network using only a server;
- Designed and deployed UrbanSense on the streets of Porto to collect key environmental data: temperature, luminosity, pollutant gases (O3, NO2, CO), particles, rainfall and wind (direction and speed). This information is transmitted through heterogeneous networks (using both real-time and DTN communications).