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# Introduction to the Special Issue on "Data Management in Vehicular Networks"

Today, the car is indisputably the most heavily used mode of transportation. Within this context, advances in wireless networks and mobile devices have motivated the development of a variety of programs, generally involving *Intelligent Transport Systems (ITS)*. These programs have attracted the interest of researchers both in academia and in industry. Thanks to the resulting research, *Advanced Driver Assistance Systems* (*ADAS*) were born. Some ADAS are already available on the market (e.g., navigation systems, warning systems to alert the driver when he/she is about to fall asleep in order to prevent him/her from crossing the road's centre line, etc.), and many others are under development. The goal is to provide the driver with services that can help make the driver experience more comfortable, pleasant, and safe.

The recent development of mobile technologies (e.g., wireless networks, mobile devices, etc.) has led to the emergence of vehicular networks, which have received a lot of attention these last years, as a medium to provide assistance to drivers. Several applications are already available on smartphones, such as Waze[1], Roadify[2], or Apila[3], which allow drivers to share information about traffic conditions or available parking spots. Although such applications suffer from some limitations (e.g., required 3G connection, presence of false events due to invalidation problems or malicious behaviors, no assistance provided to drivers when no events have been recently reported by users, etc.), they constitute first valuable contributions in this application field.

Two forms of communication between vehicles are possible: *inter-vehicle communications* (*IVC*), also called *vehicle-to-vehicle* (*V2V*) communications, and *infrastructure-based communications*. IVC relies on short-range networks (about one hundred meters), like IEEE 802.11 or Ultra Wide Band (UWB) standards, for vehicles to communicate, and provides a bandwidth in the range of Mbps. Using such communication networks, the driver of a car can receive information from its neighbours and disseminate relevant data to other vehicles within its communication range. On the other hand, an infrastructure-based communication implies the use of a support infrastructure, such as hotspots deployed along a motorway or a wide-area communication technology (e.g., 3G).

Both types of communication can be used to deliver different types of contents/data to drivers. For example, IVC could be used to inform drivers that an accident has occurred or that an obstacle has appeared on the road a few hundred meters ahead. With an infrastructure-based approach, sensors deployed along the network could inform about events such as traffic jams, parking spaces released or prices of petrol stations nearby, or provide Internet services to vehicles.

Whereas numerous works have focused on the design of network protocols (e.g., dissemination protocols at the network level, geographic routing protocols, etc.) for vehicular networks, less attention has been paid to data management issues. Today,

[1] http://world.waze.com/
[2] http://www.roadify.com/
[3] http://www.apila.fr/

although vehicular networks open up very interesting opportunities for the development of original data services, many challenges lie ahead. For example, data should be released only within the area where they could be interesting, in order not to communicate irrelevant information or waste network resources. Moreover, not only the spatial criterion is important here, since a piece of information is usually valid only for a limited period of time. Both the heterogeneity of data providers (e.g., sensors, neighboring vehicles, Web services, etc.) and intermittent network connections can make data access a difficult task; thus, for example, while two moving vehicles exchange data using V2V they could get out of range of each other. Obviously, trust and privacy issues are also a major concern in such environments, where personal information (e.g., the location of the user, his/her driving behavior, etc.) is managed.

The purpose of this special issue is to present an overview of the current state of the art and a prospective of the research issues that need to be solved in order to provide drivers with different types of data services. The special issue opens up with an invited article contributed by Ouri Wolfson, Prasad Sistla and Bo Xu, who offer their vision on the problem of data management in vehicular networks and introduce a query language, called TranQuyl, for Data Management in Intelligent Transportation Systems. Then, among all the submissions received for the special issue, we finally selected 8 articles, which cover a variety of interesting aspects related to data management in vehicular networks.

First, the paper titled "Adaptive Data Dissemination for Time-constrained Messages in Dynamic Vehicular Networks" (by Kai Liu and Victor C. S. Lee) proposes an approach for timely and adaptive data dissemination under the effects of dynamic traffic factors. Bartłomiej Płaczek, with the paper "Selective data collection in vehicular networks for traffic control applications", introduces a method for selective traffic data collection for traffic control applications, which leads to a reduction of the amount of data transferred. The context of traffic information systems is also the target scenario for the following two papers. First, "An Evaluation Framework for Traffic Information Systems Based on Data Streams" (by Sandra Geisler, Christoph Quix, Stefan Schiffer and Matthias Jarke) presents an evaluation framework for traffic information systems based on data streams, which is applied for queue-end detection and traffic state estimation. Second, "Sampling Methods for Summarizing Unordered V2V Data Streams" (by Jiadong Zhang, Jin Xu and Stephen Shaoyi Liao) studies methods for summarizing traffic data streams, avoiding the assumption that the input data arrive in order. The paper "Analysis of the Information Storage Capability of VANET for Highway and City Traffic" (by Bojin Liu, Behrooz Khorashadi, Dipak Ghosal, Chen-Nee Chuah and Michael Zhang) study the capability of VANETs to keep certain transient information within a certain region during a specific period of time. The next paper, "Hindering False Event Dissemination in VANETs with Proof-of-Work Mechanisms" (by Esther Palomar, José M. de Fuentes, Ana I. González-Tablas and Almudena Alcaide), focuses on security in VANETs and proposes the application of cryptographic techniques to discourage vehicles from transmitting false event messages and to obtain non–repudiation evidence for different types of bad behavior within a VANET. "Evaluation of GPS-Based Methods of Relative Positioning for Automotive Safety Applications" (by Thomas Williams, Paul Alves, Gerard Lachapelle and Chaminda Basnayake) focuses on the problem of relative positioning in vehicular networks, which is important because it affects the amount of data that can be shared over the wireless medium. Finally, "Spatio-Temporal Similarity of Network-Constrained Moving Object Trajectories using Sequence Alignment of Travel Locations" (by Sajimon

Abrahama and P. Sojan Lalb) addresses the problem of network-based trajectory similarity.

We sincerely thank all the authors for submitting their work to this TR-C special issue and the reviewers for contributing to the enhancement of the selected articles with their detailed comments. Besides, we express our gratitude to Pr. Markos Papageorgiou, Editor-in-Chief of the Transportation Research Part-C (Emerging Technologies) journal, for hist time and the support he devoted to us throughout the preparation of this special issue.

To conclude, we really hope that you will enjoy reading this TR-C special issue as much as we enjoyed editing it.

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