Chapter 4

Real Time Acquisition of Traffic Information through V2V, V2R, and V2I Communications

Alessandro Bazzi  
National Research Council (CNR-IEIIT), Italy

Barbara M. Masini  
National Research Council (CNR-IEIIT), Italy

Gianni Pasolini  
University of Bologna, Italy

ABSTRACT

Many vehicles are currently equipped with On-Board Units (OBUs) that are in charge of collecting and processing data for some specific purposes (such as for travel monitoring, as requested by many insurance companies). These devices are connected to the cellular network by means of their Vehicle-to-Infrastructure (V2I) communication interface, and are thus able to transmit and receive information also related to real time traffic, pollution, local events, etc. Of course, as the number of OBU-equipped vehicles increases, the cost of this service increases as well, both in terms of network load and billing. In this chapter, the authors discuss the possibility of taking advantage of vehicle-to-vehicle (V2V) and Vehicle-to-Roadside (V2R) communications to save V2I resources, thus reducing the cellular network burden and, consequently, the service cost.

INTRODUCTION

Making road traffic safer and smarter is a challenge that researchers, industries, and standardization bodies are facing worldwide. A fundamental contribution to the achievement of this objective is provided by wireless communications networks, which are enabling advanced services targeted to Intelligent Transportation Systems (ITS).

As a matter of fact, an increasing number of vehicles travelling worldwide is currently equipped with monitoring devices that make them act as

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sensors collecting and transmitting information about themselves and their surroundings. These equipments embed a Global Positioning System (GPS) receiver, a cellular device providing a Vehicle-to-Infrastructure (V2I) interface, and, in case, other sensors.

Several applications that target transport efficiency could make use of the vast information collected by vehicles: safety, traffic management, smart navigation, pollution monitoring, tourist information, etc. (Conti, 2009). In Italy, for instance, huge amount of data concerning vehicles’ position and speed (and ultimately, the traffic on the road network) are acquired by over one million vehicles equipped with On-Board Units (OBUs) (Bazzi, 2010). OBUs continuously collect and store information about the vehicle status (position, speed, acceleration, etc.); these data are periodically sent to a traffic-monitoring control center, which can therefore derive, in real time, the average vehicular speed in any given road travelled by OBU-equipped cars.

Providing this information back to vehicles (including those without the OBU) allows on-board navigators to always choose the optimal route to the destination on the basis of the actual traffic conditions.

Apart from third party OBUs, some navigators’ manufacturers directly embed this traffic monitoring capability in their top-level products, which are therefore equipped with a cellular communication device.

Of course, in both cases the service cost is highly affected by the frequent transmissions carried out over the cellular network. These costs are usually hidden in the service subscription fee and represent an obstacle to the widespread diffusion of this kind of devices, which is a fundamental condition to have an accurate monitoring of the road network.

Even not considering economical aspects, the frequent transmissions performed by on-board devices could overload the mobile network, thus reducing the quality of service experienced by users. Moreover, transmissions performed by uncoordinated devices would refer, in many cases, to the same road segment, thus causing an useless resource occupation; if OBUs were able to communicate to each other through a Vehicle-to-Vehicle (V2V) interface, measurements performed almost simultaneously by different vehicles over the same road could be merged before being transmitted to the control center over the cellular network, thus avoiding duplicates and reducing the overall cost of the service as well as increasing the network efficiency and the quality of service (Campolo, 2010).

Of course, the presence of a dedicated roadside communication infrastructure, able to collect data coming from vehicles and to forward in the opposite direction (toward vehicles) information coming from the control center, would further reduce the load offered to the cellular network, with obvious advantages in terms of cost and resource saving.

In this chapter we investigate the advantages achievable by sharing, aggregating and transmitting the collected traffic information through short range ad hoc V2V and Vehicle-to-Roadside (V2R) communications aimed at reducing cellular V2I connections from vehicles to the control center. The benefits will be assessed adopting a simulation platform that takes into account a realistic vehicular traffic in an urban area, simulated through the microscopic Vissim commercial tool (Vissim, 2010), and network aspects through the simulation platform for heterogeneous interworking networks (SHINE) developed in our laboratories (Bazzi, 2006).

Answers will be given in particular to the following questions:

- Which are the advantages provided by V2V communications?
- Which are the further benefits that can be achieved providing vehicles also with V2R communication capabilities?
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