Chapter 12
On the Dissemination of IEEE 802.11p Warning Messages in Distributed Vehicular Urban Networks

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ABSTRACT
IEEE 802.11p is a technology used for communication among vehicles, related to security issues, warning of incidents, or mere exchange of different types of information. Future cars will have the ability to communicate among them and with roadside data systems to spread information about congestion, road conditions, and accidents. They will also have access to travel-related Internet services, publicity from business nearby, tourist information, or even to exchange user files. In this chapter, the authors base their work on an ad-hoc highly configurable agent-based simulator that models communication among cars in a distributed vehicular urban network. Using this model, they provide different measurements concerning coverage and dissemination times to describe the behavior of the standard protocol for disseminating warning messages. Based on the results obtained, the chapter presents proposals to enhance the behavior of the protocol, some of them changing the specification, and others with the use of location-based information.

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INTRODUCTION

Traffic accidents are one of the main causes of human death, being even higher than deadly diseases or natural disasters (Yang et al., 2004). In fact, every year 1.2 million persons die and 50 million get injured in road traffic accidents (Peden et al., 2004). However, there are some studies like (Wang and Thompson, 1997) which show that if the driver was warned with at least one-half second prior to a collision, more than 50% of collisions could be avoided.

The Intelligent Transportation Systems (ITSs) are a set of technical solutions to improve the operation, security and efficiency of transportation systems. The main goals are the reduction of fatalities and financial losses due to traffic accidents, and also the reduction of expenses caused by traffic congestion (in 2007, the extra costs caused by time lost and fuel in 439 urban areas in the US were $87.2 billion dollars, 10600 litters of wasted fuel and a yearly delay for the average peak-period traveler of 36 hours (Texas Transportation Institute, 2009)). Besides the services mentioned above, there is also a motivation to provide private services, as Web access, file sharing, and many others. There is a huge economic interest in this area to improve traffic safety and save lives on road. Besides, vehicle-to-vehicle communication allows the sharing of the wireless channel to improve route planning and traffic congestion (Martinez et al., 2008). Due to this, many communication protocols and methodologies are being developed trying to improve this kind of communications (Wischof and Ebner, 2005).

Many countries have joined this research field, presenting projects to provide safety in roads, and to be able to detect non-safe situations before they appear. We can mention the Vehicle Safety Communications Consortium in the US, the Internet ITS Consortium (http://www.internetits.org) in Japan, and the Car-to-Car (C2C) Communications Consortium (http://www.car-to-car.org) in Europe. Besides their main goal of improving safety, they also deal with comfort, transport efficiency and entertainment applications.

In 1999, the US Federal Communications Commission allocated 75 MHz of licensed spectrum of Dedicated Short Range Communications, from 5.8 to 5.925 GHz, to be used in the Intelligent Transportation Systems. This band is used exclusively for vehicle-to-vehicle and vehicle-to-infrastructure communications.

C2C technology, which is akin to Mobile Ad-Hoc networks, provides communications among nearby vehicles and between vehicles and nearby fixed equipment, usually described as roadside equipment. A new family of standards is being developed to ensure these communications. The WAVE (Wireless Access in Vehicular Environments) communications standards, developed for the US Department of Transportation (DOT), describe the architecture and protocols for C2C communications. Also, IEEE is developing a family of standards, IEEE 1609. The IEEE 1609.2 standard deals with methods for securing WAVE messages against eavesdropping, spoofing, and other attacks. The IEEE 1609.1 standard deals with managing multiple simultaneous data streams, memory, and other system resources. The IEEE 1609.4 standard primarily covers how multiple channels - including control and service channels - should operate. Finally, the IEEE 1609.3 standard touches WAVE networking services and protocols. These draft standards cover the five upper layers of the OSI protocol stack.

The two lower layers (data link and physical) are implanted by the Dedicated Short Range Communications (DSRC) at 5.9 GHz. It is standardized in the IEEE 802.11p standard, a variant of 802.11a adjusted for low overhead operations and it uses the extension IEEE 802.11e Enhanced Distributed Channel Access (EDCA) for Quality of Service (QoS). These wireless access standards allow data exchange between high-speed vehicles and between the vehicles and the roadside infrastructure.