

Chapter 46

An 802.11p Compliant System Prototype Supporting Road Safety and Traffic Management Applications

Helen C. Leligou

*Technological Educational Institute of Central
Greece, Greece*

Periklis Chatzimisios

Alexander TEI of Thessaloniki, Greece

Lambros Sarakis

*Technological Educational Institute of Central
Greece, Greece*

Theofanis Orphanoudakis

*Technological Educational Institute of Central
Greece, Greece*

Panagiotis Karkazis

*Technological Educational Institute of Central
Greece, Greece*

Theodore Zahariadis

*Technological Educational Institute of Central
Greece, Greece*

ABSTRACT

During the last decades Intelligent Transportation Systems (ITS) have been attracting the interest of an increasing number of researchers, engineers and entrepreneurs, as well as citizens and civil authorities, since they can contribute towards improving road transport safety and efficiency and ameliorate environmental conditions and life quality. Emerging technologies yield miniaturized sensing, processing and communication devices that enable a high degree of integration and open the way for a large number of smart applications that can exploit automated fusion of information and enable efficient decisions by collecting, processing and communicating a large number of data in real-time. The cornerstone of these applications is the realization of an opportunistic wireless communication system between vehicles as well as between vehicles and infrastructure over which the right piece of information reaches the right location on time. In this paper, the authors present the design and implementation of representative safety and traffic management applications. Specifically the authors discuss the hardware and software requirements presenting a use case based on the NEC Linkbird-MX platform, which supports IEEE 802.11p based communications. The authors show how the functionality of IEEE 802.11p can be exploited to build efficient road safety and traffic management applications over mobile opportunistic systems and discuss practical implementation issues.

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1. INTRODUCTION

Road safety, air pollution and traffic management are three major concerns that the residents of urban centers around the world have to face promptly given the radical growth in cities' population. Road traffic accident mortality is high among young people with transport accidents causing 8% of all loss below 65 years in the EU-27 (Cayotte & Buchow, 2009), more than any disease. Across European Union (EU), transport is most dangerous in regions in Portugal, Lithuania, Latvia, Corsica, Greece and Poland. While road traffic injuries are a major cause of death and disability globally, a disproportionate number occur in developing countries. Road traffic injuries are currently ranked ninth globally among the leading causes of disability adjusted life years lost, and the ranking is projected to rise to third by 2020. In 1998, developing countries accounted for more than 85% of all deaths due to road traffic crashes globally and for 96% of all children killed (Murray & Lopez, 1996), (Nantulya & Reich). On the other hand, air pollution is tightly related to traffic management and plays a substantial role to the climate change while burdening the commitment of Europe to decrease the CO₂ emissions. In urban areas, an increase in average speed may dramatically reduce fuel consumption, while traffic signal synchronization has the potential to increase intersection throughput for private traffic by 15%. Guiding traffic (e.g. through route advisory systems) away from problematic areas may lead to up to 8% less emissions (Murray & Lopez, 1996). Today, 30% of energy is consumed for transportation of humans and goods (Panorama of Transport, 2009) and circa 18% of the CO₂ emissions from combustion coming from road transportation (IEA, 2005). Although the broadening of the road infrastructures increases their capacity, it cannot keep up with the pace of the increase in urban populations worldwide, due to cost and time reasons, leading the city authorities to pursue "soft" measures to solve the problem (Pincus, 2011). Furthermore,

there are many efforts by the scientific community to combat many critical issues that hold back the vehicular network's deployment but also support the Intelligent Transportation Systems (ITS) development by performing standardization efforts concerning vehicular communications (Kadas & Chatzimisios, 2011; Leontiadis et al., 2011).

To tackle the previously reported issues and problems, the design and development of ITS has been pursued extensively the last decade. These systems rely on intelligent collection and processing of information which enables decision making and information/decision dissemination to enhance the citizen's experiences either through enhancing transportation efficiency or safety. They can be classified in advanced public transport systems, advanced traveler information systems, advanced Traffic Management Systems, incident management systems, electronic toll collection systems, Vehicle Information and Communications System and Video Transmission Systems for road surveillance. ITS are expected to play a major role in enhancing road safety, transportation efficiency and improving environmental conditions, both in developed as well as in developing countries as mentioned above. Their impact will be critically affected by the adoption of standardized and low cost technologies that can result in massive production of commodity hardware components and wide deployment of interoperable systems.

The common denominator of the realization of all these systems is the effective communication between vehicles and infrastructure enabling real-time information collection and dissemination following a distributed architecture. While initial attempts assumed WLAN communication, IEEE has standardized the 802.11p protocol and the 1609 standard family comprising the Wireless Access in Vehicular Environments (WAVE) standards in order to define the architecture, communication model and mechanisms of high-speed short range wireless low latency communications. The original IEEE 802.11, intended for WLAN, has two drawbacks within its MAC technique CSMA;

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