Chapter 35

On-Board Unit Hardware and Software Design for Vehicular Ad-Hoc Networks

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ABSTRACT

Intelligent Transport Systems (ITS) are a focus of public authorities and research communities in order for them to provide effective solutions for improving citizens' security and lifestyle. The effectiveness of such systems relies on the prompt processing of the acquired traffic- and vehicle-related information to react to congestion and dangerous situations. To obtain a dynamic and pervasive environment where vehicles are fully integrated in the ITS, low cost technologies (capable of strongly penetrating the market) must be made available by the effort of academic and industrial research. In this chapter, the authors discuss the design and implementation of a prototype vehicular unit capable of interacting with both roadside networks and in-vehicle electronic devices. More in detail, in order to scientifically characterize the solution, the authors start from a clear statement of the requirements that the vehicle equipment should respond to. Then they detail the selection of the off-the-shelf components adopted in the prototyped on-board unit. In the last part of the chapter, the authors discuss several possible applications in which the developed device can be adopted, as well as open issues for future research activities.

INTRODUCTION

In recent years, Intelligent Transport Systems (ITS) have gained a considerable interest from both public authorities and research community. By integrating computers, electronics, satellites, and sensors in the transport systems, ITS can make every transport mode more efficient, safe and energy saving, thus improving citizens' lifestyle and drivers' security. The new generation of ITS will include an integrated approach for travel planning, transport demand, traffic management, emergency management, road pricing, and the use of parking and public transport facilities, while requiring scalable installations (in terms of costs and communication capabilities) and limited interventions of civil infrastructures (Pagano, Petracca, Alessandrelli, & Nastasi, 2011).

Due to the high importance and relative difficulties in developing new interoperable and scalable ITS, the European Parliament published in July 2010 the Directive 2010/40/EU "On the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport" (European Parliament, 2010). Together with objectives and benefits of ITS, in the Directive it is pointed out the necessity of an integrated approach among telecommunications, electronics, and information technologies with transport engineering to successfully plan, design, operate, maintain and manage transport systems. Moreover, it is underlined the necessity of adopting standards to provide interoperability, compatibility and continuity for the development and operational use of ITS. To the end of fulfilling such requirements four priority areas for the development of effective ITS have been identified:

1. Optimal use of road, traffic and travel data;
2. Continuity of traffic and freight management ITS services;
3. ITS road safety and security applications;

4. Linking the vehicle with the transport infrastructure.

The four reported priority areas identified by the European Union (EU) establish a first step towards the development of an EU-wide ITS system, and they must be considered of equal importance. However, from a research point of view, the latter point can be considered one of the most promising, but at the same time the most challenging, for an effective deployment of new ITS. In order to link vehicles with the transport infrastructure new plug-and-play measures to integrate ITS applications on an open in-vehicle platform must be considered (European Parliament, 2010), as well as the development and implementation of Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I) and Infrastructure-to-Infrastructure (I2I) cooperative systems (European Parliament, 2010). As a consequence, in-vehicle plug-and-play ITS-related solutions and roadside networks for vehicular communications must be considered as key building blocks of new generation ITS.

The possibility of establishing network communications among vehicles, and between vehicles and roadside devices (Figure 1), opens new interesting and challenging application scenarios in the ITS research field. Traffic-related data can be sent in real-time from ITS control rooms to in-vehicle equipments to the end of communicating road congestions, car accidents, alternative routes, etc., to the driver. At the same time crucial vehicle-related data, such as fuel level, break alarms, etc., coming from in-vehicle electronic devices can be sent from the vehicle to the control room, in charge of helping the driver in finding a solution (e.g., calling the closer tow truck). Two features are required to effectively integrate roadside networks in ITS: the pervasiveness of the developed hardware technologies (for both on-board and roadside units) and the use of standard interfaces and protocols. If from one hand the pervasiveness can be easily reached by developing low-cost devices, on the other hand the

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