Chapter 23
Vehicular Communications Networks:
Current Trends and Challenges

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ABSTRACT

Vehicular communications networks (VCNs) are created by vehicles equipped with short and medium range wireless communication technology. They include vehicular ad-hoc networks (VANETs), vehicle-to-vehicle and vehicle-to-infrastructure communications. VCNs enable a plethora of important applications and services, ranging from active safety or safety of life applications to traffic information, music/maps download and multi-hop internet connection. Recently, the promises of wireless communications to support vehicular safety applications have led to several national/international projects around the world. These include the consortia like Vehicle Safety Consortium (US), Car-2-Car Communication Consortium (Europe) and Advanced Safety Vehicle Program (Japan), standardization efforts like IEEE 802.11p (WAVE), and field trials like the large-scale Vehicle Infrastructure Integration Program (VII) in the US. All these efforts have as a main goal to improve safety in vehicular environments by the use of wireless communications, but also consider transport efficiency, comfort and environment. In comparison to other communication networks, VCNs come with unique attractive features: unlimited transmission power, predictable mobility and plethora of potential applications. However, to bring its potency to fruition, VCNs have to cope with formidable challenges that include: rapidly changing topology subject to frequent fragmentations and congestions, lack of connectivity redundancy, and the stringent application requirement on real-time and robust message delivery. In this chapter, we present a detailed description of the state of the art of this fast-moving research area pointing to research, projects and standardiza-

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Road safety has been an important concern in the world over the past few years since millions of people die every year because of car accidents and many more are injured. Current statistics show that road traffic accidents in the Member States of the European Union annually claim about 39,000 lives and leave more than 1.7 million people injured, representing an estimated cost of 160 billion euros (http://europa.eu.int/comm/transport/care/indexen.htm).

Automated highway systems and intelligent transportation systems (ITS) were introduced to accelerate the development and use of intelligent integrated safety systems that use information and communication technologies as an intelligent solution, in order to increase road safety and reduce the number of accidents in our future roads. In contrast, as mobile wireless devices became an essential part of our lives, and the ubiquitous ‘anywhere, anytime’ connectivity concept is gaining attraction, Internet access from vehicles is in great demand. The proliferation of cooperated system approach for ITS and the focus on information and communications technologies (ICT) services on one hand and the growing number of communication infrastructure-enabled vehicles on the other hand has opened up new business models and key market segments for many stakeholders in the ITS-market.

Vehicular Communication Networks (VCNs) are a cornerstone of the envisioned Intelligent Transportation Systems (ITS). By enabling vehicles to communicate with each other via Inter-Vehicle Communication (IVC) as well as with roadside base stations via Roadside-to-Vehicle Communication (RVC), vehicular networks could contribute to safer and more efficient roads.

The opportunities and areas of applications of VCNs are growing rapidly, with many vehicle manufacturers and private institutes actively supporting research and development in this field. The integration with on-board sensor systems, and the progressive diffusion of on-board localization systems (GPS) make VCNs suitable for the development of active safety applications, including collision and warning systems, driver assistant and intelligent traffic management systems. On the other hand, inter-vehicular communication (IVC) also fuels the vast opportunities in online vehicle entertainment (such as gaming or file sharing), and enables the integration with Internet services and applications (Nandan et al., 2004).

In this chapter, we present a detailed description of the state of the art of this fast-moving research area pointing to research, projects and standardization efforts that have been done. We explore the unique features and challenges that characterise these highly dynamic networks as well as their requirements, especially in terms of quality of service, market introduction and security. We discuss various forwarding and routing strategies focussing on position-based techniques including ‘anchor-based routing’. We survey various ‘intelligent flooding’ and information dissemination approaches. Scenarios for highways and cities are taken as example. We conclude by exploring future research directions in this field.