

Chapter 8.8

Infrastructures in Vehicular Communications: Status, Challenges and Perspectives

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ABSTRACT

Vehicular communication is regarded as a backbone for the development of intelligent transportation system (ITS). Recently vehicular communication has attracted researchers from both academia and industry all over the world, notably, in the United States of America, Japan and European Union. The rapid advances in wireless technologies provide opportunities to utilize them in vehicular communication in advanced road safety applications. The most important feature of vehicular communication is to improve the road traffic safety, efficiency, comfort and quality of everyday road travel. Networking in particular and communication in general are important rudiments in the development of ITS. Generally, in vehicular communication, the information exchange occurs among vehicles not only in an ad-hoc based vehicle-to-vehicle networking but also in a vehicle-to-infrastructure with possible intermediate infrastructure-to-infrastructure networking. Therefore, the infrastructure plays major role in order to realize the full potential of vehicular communications. This chapter provides an in-depth survey of the infrastructures and technologies that are recently proposed as part of future ITS developments as well as tested for vehicular communications in mobile environment. Specifically, we provide an in-depth analysis of wireless technology-applications such as ad-hoc networking and wireless local area network (WLAN), dedicated short-range communication (DSRC), cellular technology and NOTICE Architecture, and compare their characteristics in terms of their abilities to support vehicular communications for development of ITS.

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I. INTRODUCTION

Vehicular communication is an emergent technology that has recently deserve attention of both industry and academic institutions all over the world, notably, in United States of America, Japan and Europe for the development of ITS. The main idea behind ITS is not new since JSK (Association of Electronic Technology for Automobile Traffic and Driving of Japan) was instantiated to work on vehicular communications in the early 1980s. However, the formal development process in the United States of America began in 1990s when the United States Congress mandated the creation of a program called Intelligent Vehicle Highway System (IVHS) based on Intermodal Surface Transportation Efficiency act of 1991 (ISTEA), whose main goal was to improve road safety, efficiency, comfort and quality of everyday life reducing possible pollution and preserving fuel while traveling on the road. The main responsibility of IVHS was assigned to the U.S. Department of Transportation (U.S. DOT), which required the advice of the Intelligent Transportation Society of America (ITSA).

Recently well-known research results on platooning have been demonstrated by California PATH project of USA (Alvarez & Horowitz, 1997) and Chauffeur of EU. Vehicular communication is regarded as a major component for ITS to enhance passenger comfort, traffic efficiency, safety of passengers and so on, by propagating and disseminating the information in a timely and accurate manner towards the region of interest with an aim of automating existing transportation system which will rely on vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) with possible intermediate infrastructure-to-infrastructure (I2I) communications. Conventional solutions to these issues use mainly automatic control systems using on board unit (OBU) in individual vehicles without any interaction to other vehicles, however, recently proposed vehicular communication could help to make the coordination among participating

vehicles more efficiently and effectively with the help of inter-vehicle communication using V2V and/or V2I communications.

Generally speaking, there are four basic types of information or messages that are exchanged among vehicles in vehicular communications:

- *Emergency and warning messages:* These types of messages can be of critical emergency, construction sites, or congestion related messages.
- *Routing and basic safety messages:* This category consists of information used by routing protocols and driving conditions. Information related to sender vehicle's speed, position, direction, identity and so on are some examples.
- *Infotainment (information and entertainment) messages:* These types of messages are basically related to recourses and services available on the roadside, and/or the services offered by other participating vehicles on the road. Information for nearby gas stations, restaurants, and so on are the example of this category.
- *Inter-personal messages:* This category may contain messages related to a profile of a driver and other passengers on the vehicle.

In V2V communication, individual vehicles work as a source, a destination and/or a router to propagate and disseminate the information towards the destination region, and the communication relies on information received from other participating vehicles on the road. Frequent breakage in network connection in V2V communication might happen because of dynamic change in vehicular network topology as a result of high mobility of vehicles in different traffic conditions, such as during traffic jams, accidents, traffic lights, rush hours, late night, school areas, etc. One way of making long time V2V connections for communication is by increasing the transmission range

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