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# Infotainment and road safety service support in vehicular networking: From a communication perspective ☆

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ABSTRACT

Vehicular ad hoc networking is an emerging technology for future on-the-road communications. Due to the virtue of vehicle-to-vehicle and vehicle-to-infrastructure communications, vehicular ad hoc networks (VANETs) are expected to enable a plethora of communication-based automotive applications including diverse in-vehicle infotainment applications and road safety services. Even though vehicles are organized mostly in an ad hoc manner in the network topology, directly applying the existing communication approaches designed for traditional mobile ad hoc networks to large-scale VANETs with fast-moving vehicles can be ineffective and inefficient. To achieve success in a vehicular environment, VANET-specific communication solutions are imperative. In this paper, we provide a comprehensive overview of various radio channel access protocols and resource management approaches, and discuss their suitability for infotainment and safety service support in VANETs. Further, we present recent research activities and related projects on vehicular communications. Potential challenges and open research issues are also discussed.



## 1. Introduction

Vehicular transportation is one of the crucial means of transportation around the world. Regardless of its convenience, there are more than one million human casualties due to vehicle crashes worldwide every year [1]; therefore, road traffic safety remains a big concern in our daily life. Over the years, governments and automotive industries have been working together to improve road traffic safety through various intelligent transportation system (ITS) initiatives. For example, in October 2008, the United States Department of Transportation laid out an aggressive goal of reducing vehicle crashes by 90% by 2030 [2]. Similar efforts have also been made in Europe and Asia [3,4]. To realize the vision of accident-free transportation, automobile manufacturers have been striving to assemble vehicles with sophisticated hardware components (such as sensors and cameras) and software programs (such as image recognition) [5]. Various active and passive safety measures intended to reduce the number and severity of accidents are also implemented in today's vehicles (e.g., GM OnStar automatic crash response system [6]).

To further enhance transportation safety, communication-based safety applications empowered by vehicular ad hoc networking have recently attracted a lot of attention from industry and academia [7,8]. Via inter-vehicle communications, drivers can be informed of crucial traffic information such as treacherous road conditions and accident sites by

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communicating with each other and/or with the roadside infrastructure. With better knowledge of traffic conditions, it is plausible that the problem of accidents can be alleviated. Traffic monitoring and management can also be facilitated by vehicular communications (e.g., vehicle platooning [9,10]) so as to elevate traffic flow capacity and improve vehicle fuel economy. On the other hand, convenience and commercial in-vehicle applications are envisioned to be supported in future automobiles, for example, live video streaming, file sharing, remote vehicle diagnostics, traffic jam notification, mobile office, advertisement, and gaming [11–13]. Clearly, these on-the-road data and entertainment services can greatly increase vehicle occupants' productivity, satisfaction, and/or comfort. In short, communication-based automotive applications are promising in providing safer and more fuel efficient use of vehicles, increasing vehicle throughput on the road (i.e., vehicles per lane per hour), and supporting diverse in-vehicle infotainment applications.

### 1.1. Architecture of vehicular networking

Vehicular ad hoc networks (VANETs) belong to a general class of mobile ad hoc communication networks with fast-moving nodes (i.e., vehicles). In specific, a VANET consists of (1) on-board units (OBUs) built into vehicles and (2) roadside units (RSUs) deployed along highways/sidewalks, which facilitates both vehicle-to-vehicle (V2V) communications between vehicles and vehicle-to-infrastructure (V2I) communications between vehicles and RSUs. An illustration of a functional VANET architecture is given in Fig. 1. Via wireless communication links, each vehicle communicates with nearby vehicles in a highly dynamic ad hoc networking environment. Traffic-related information can be exchanged via V2V communications (e.g., through periodic beaconing) to allow drivers to be better aware of surrounding traffic conditions. In case of emergency, event-driven messages can be generated and disseminated to the vehicles in the zone of danger (or zone of relevance, ZOR) [14]. Peer-to-peer applications such as information sharing and gaming can also be supported through V2V communications.

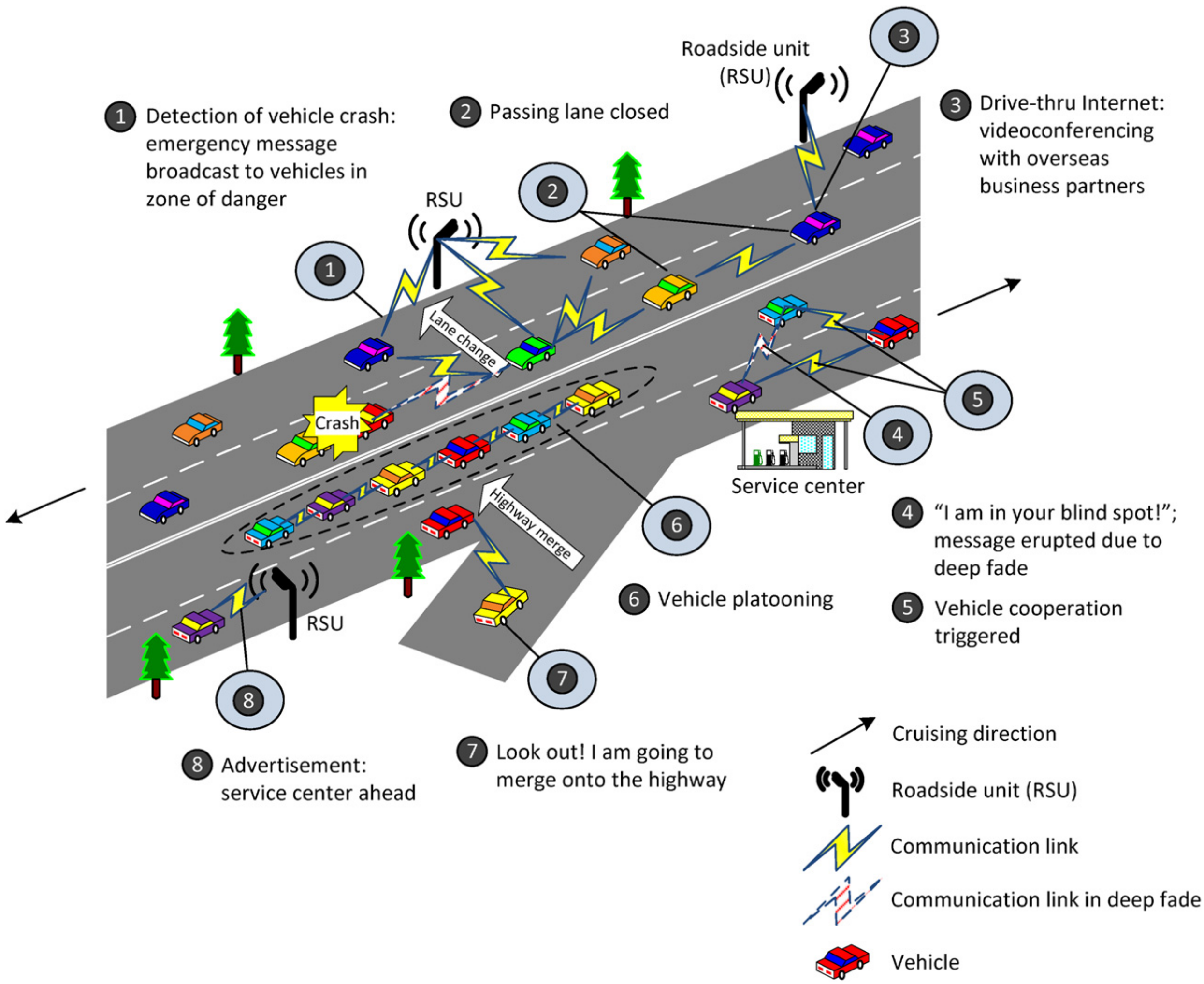


**Fig. 1.** An illustration of a VANET.