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## A comprehensive survey on vehicular Ad Hoc network

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### ABSTRACT

Vehicular ad hoc networks (VANETs) are classified as an application of mobile ad hoc network (MANET) that has the potential in improving road safety and in providing travellers comfort. Recently VANETs have emerged to turn the attention of researchers in the field of wireless and mobile communications, they differ from MANET by their architecture, challenges, characteristics and applications. In this paper we present aspects related to this field to help researchers and developers to understand and distinguish the main features surrounding VANET in one solid document, without the need to go through other relevant papers and articles starting from VANET architecture and ending up with the most appropriate simulation tools to simulate VANET protocols and applications.

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### 1. Introduction

At the present time cars and other private vehicles are used daily by many peoples. The biggest problem regarding the increased use of private transport is the increasing number of fatalities that occur due to accidents on the roads; the expense and related dangers have been recognised as a serious problem being confronted by modern society. VANET provides a wireless communication between moving vehicles, using a dedicated short range communication (DSRC). DSRC is essentially IEEE 802.11a amended for low overhead operation to 802.11p; the IEEE then standardises the whole communication stack by the 1609 family of standards referring to wireless access in vehicular environments (WAVE). Vehicle can communicate with other vehicles directly forming vehicle to vehicle communication (V2V) or communicate with fixed equipment next to the road, referred to as road side unit (RSU) forming vehicle to infrastructure communication (V2I) (Olariu and Weigle, 2009; Moustafa and Zhang, 2009; Jiang et al., 2006).

These types of communications allow vehicles to share different kinds of information, for example, safety information for the purpose of accident prevention, post-accident investigation or traffic jams. Other type of information can be disseminated such as traveller related information which is considered as non-safety information. The intention behind distributing and sharing this information is to provide a safety message to warn drivers about expected hazards in order to decrease the number of accidents and save people's lives, or to provide passengers with pleasant journeys.

This field attracts researchers from different fields to develop VANET applications, protocols and simulation tools. Several challenges are facing researchers and developer. Therefore, several papers and articles have tried to cover these issues. Hartenstein and Laberteaux (2008) have investigated the communication and networking aspects of this technology and addressed the security and privacy issues. While, Li and Wang (2007) focus on the routing protocols of VANET and their requirements to achieve better communication time with less consumption of network bandwidth. Lin et al. (2010) investigate the categories of routing protocols in VANET and the idea behind each of them. In this paper, we present a key document which can provide detailed information to researchers and developer so as to understand the main aspects and challenges related to VANET. It covers different issues such as network architecture, communication domains, challenges, applications and simulation tools.

The rest of this paper is structured as follows. We start in Section 2 with describing the network architecture. Section 3 presents the communication domains in VANET. In Section 4, we discuss the wireless access technologies that can be used to establish the communication of the network. Section 5 presents the unique characteristics of VANET. Network challenges and requirements are discussed in Section 6. Section 7 will give a comprehensive explanation for the applications enabled by VANET communications. VANET simulation tools are given in Section 8 before we sum up our paper with a conclusion in Section 9.

### 2. VANET architecture

The communication between vehicles, or between a vehicle and an RSU is achieved through a wireless medium called WAVE.

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### \*A comprehensive survey on vehicular Ad Hoc network\*

مطالعه ای جامع بر:

#### شبکه های اد هاک خودرویی (شبکه های موردی)

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#### چکیده

شبکه های خودرویی<sup>۱</sup> (Vanet) را می توان به عنوان یکی از اپلیکیشن های شبکه های موردی سیال (شبکه های اد هاک)<sup>۲</sup> (manet) در نظر گرفت که می تواند منجر به بهبود ایمنی در جاده ها و راحتی مسافران گردد. اخیراً، در حوزه ی ارتباطات سیال و بی سیم، این نوع شبکه ها زبانزد پژوهشگران زیادی قرار گرفته است و از این رو این پژوهشگران، MANET را بر اساس معماری ها، چالش ها، مشخصه ها و اپلیکیشن های آن مورد تمایز قرار داده اند. در این مقاله قصد داریم جنبه های مرتبط با این حوزه را بررسی نماییم، با این هدف که بتوان ویژگی های اصلی VANET را در یک سند یکپارچه درک کرده و مورد تمایز قرار داده، تا کمکی به پژوهشگران و توسعه دهندگان نماییم، با این شرط که نیازی هم به مقالاتی مرتبط با معماری VANET نباشد و مناسب ترین ابزار های شبیه سازی را به منظور شبیه سازی پروتکل های VANET و اپلیکیشن های آن بتوان بدست آورد.

**کلید واژه:** شبکه های خودرویی، اپلیکیشن های ایمنی، شبیه سازی VANET، چالش ها در VANET

<sup>۱</sup> Vehicular ad hoc networks  
<sup>۲</sup> Mobile ad hoc network