Chapter 13
Vehicular Ad Hoc Networks (VANETs): Architecture, Challenges, and Applications

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ABSTRACT

Over the past few years, there has been significant research interest in field of vehicular ad hoc networks (VANETs). Wireless communication over VANETs supports vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) communication. Such innovation in wireless communication has improved our daily lives through road safety, comfort driving, traffic efficiency. As special version of MANETs, VANETs bring several new challenges including routing and security challenges in data communication due to characteristics of high mobility, dynamic topology. Therefore, academia and the auto mobile industry are taking interest in several ongoing research projects to establish VANETs. The work presented here focuses on communication in VANETs with their routing and security challenges along with major application of VANETs in several areas.

INTRODUCTION

In recent years, mobile computing has enjoyed a tremendous rise in popularity. The continued minimization of the cost of mobile computing devices and the extraordinary rise of processing power in mobile, laptop, and computers are the main reasons behind this growth. This leads to providing better mobile-

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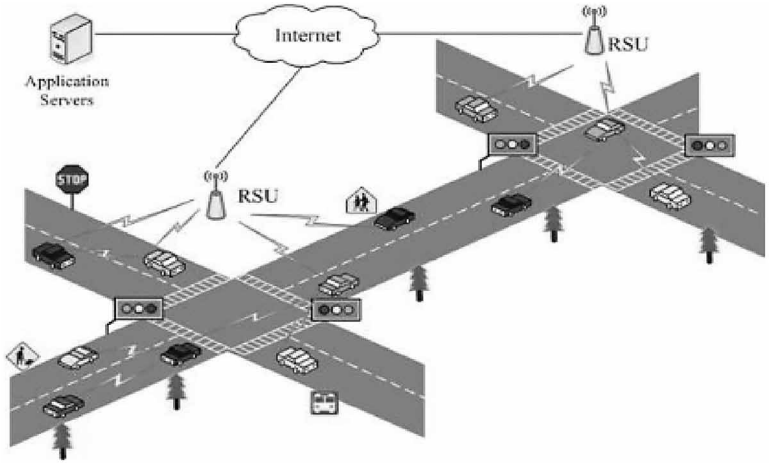
Figure 1. Vehicular ad-hoc network (VANET)



based applications into the hands of a growing segment of the population. Therefore, wireless mobile computers or mobile ad hoc networks (MANETs) have become very popular in recent years.

A mobile ad hoc network is a collection of autonomous nodes or terminals that communicate with each other by forming a multi-hop radio network. Nodes in MANETs maintain connectivity in a decentralized manner (Sarkar et al., 2016). Since, the nodes communicate over wireless links, they must contend with the effects of radio communication such as noise, fading, and interference. Additionally, the links are typically having less bandwidth than in a wired network. MANETs are characterized by mobility of nodes, and dynamic topology that makes routing more challenging. The decentralized nature of MANETs makes them suitable for a variety of applications. MANETs are more useful for environment where nodes are frequently changing their positions with reduced bandwidth.

Vehicular ad hoc networks (VANETs) are one of the prominent sub-classes of MANETs. Vehicular Ad Hoc Networks (VANETs) are wireless networks, where vehicles are connected to each other's and can be connected to the internet also (Basagni et al., 2013). VANETs are a special subclass of Mobile Ad Hoc Networks (MANETs), where nodes can move freely without any movement constraint. Each node will have to be connected by following changes in its locations. Consequently, VANETs have highly dynamic topology. The nodes can communicate with each other either in single-hop or multi-hop channel, and nodes in VANETs can be any vehicle or Road Side Unit (RSU). However, VANETs also come with several challenging characteristics, such as potentially large scale and high mobility.

The nodes in the vehicular environment are much more dynamic because most cars usually move at a very high speed and change their positions constantly. However, there is a pattern in the mobility of nodes and randomness is less as compared to other mobile networks. As per Figure-1, VANETs form a communication network by using vehicles and RSUs, where vehicles have participated as mobile nodes connected in an ad-hoc manner. Every participating vehicle behaves like a wireless router or node to communicate with each other. The fixed roadside units like traffic light towers establish in VANETs as the backbone of a network to provide connectivity for exchanging safety-related information reliably.

The VANETs architecture can be further divided into three layers. First one is the sensor layer which uses On-Board Units (OBUs) installed in vehicle and other devices sense the vehicles around and collect traffic data. Second is the communication layer that includes cellular networks and the internet to