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Traffic Analysis of Vehicular Ad-Hoc Networks of V2I Communication

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Abstract

Vehicular Ad-Hoc Network (VANET) has been emerged as a promising technology thanks to the recent advances in mechanics, networking, and information technologies. However, there is still a great deal of additional research required before it finally becomes a mature technology. This article concentrates on two factors which are holding back the development of VANETs. Firstly, there is a lack of traffic analysis & modeling for VANETs. Secondly, network optimization for VANETs needs more investigation. Among these two factors, the understanding regarding the traffic dynamics within VANETs provide a basis for further works on network optimization and anomaly detection for VANETs.

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Keywords: Quality of service (QoS); Roadside unit (RSU); Medium access control; VANET; Traffic analysis.

1. Introduction

With the advancement of technology, Ad-hoc Network is becoming a latest mode of communication with anywhere anytime service. To cope up with the demand the future wireless networks will combine high speed vehicles for communications with the present Internet infrastructure to communicate, access information, transact business, and provide entertainment. The demand of Internet connectivity is increasing exponentially, multiple services (like internet, multimedia applications) as well as better Quality of Service (QoS) are on high demand but the resources are limited. VANET is the technology of building a robust Ad-hoc network between Mobile Vehicles and each other, besides between mobile and Roadside Unit (RSU)[1–18].

The future of wireless ad-hoc network will face the challenge to combine high-speed mobile vehicular communications with the present Internet infrastructure to provide multiple services when they are moving. V2V and V2I communications allow the development of a large number of applications and can provide a wide range of information to drivers and travelers. Integrating on-board devices with the network interface, different types of sensors and GPS receivers grant vehicles the ability to collect process and disseminate information about itself and its environment to other vehicles in close proximity to it. That has led to enhancement of road safety and the provision of passenger comfort. Hence, traffic engineering is required to support different applications as they have different service requirements. For optimum performance, researchers and engineers must devise efficient techniques for mobility

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Table 1. Default parameter value for IEEE 802.11p between V2I interactions.

Parameter	Starting values
Scanning Mode	Passive
Beacon Interval	300 ms
Probe Delay	10 ms
Min Channel Time	20 ms
Max Channel Time	50 ms
Channel Time	300 ms

management and resource allocation to meet next generation demand. Mobility model analysis studies how vehicles move in the network. As the entities in VANETs are highly mobile vehicles, the fundamental characteristics of vehicular mobility, such as how vehicles rendezvous in terms of frequency and duration, how they visit a location and how wide they can cover a region of interest in both space and time dimensions, are therefore crucial to the design and ultimate performance of network protocols.

To achieve the goal of designing robust and reliable cellular wireless networks, understanding the characteristics of traffic and mobility prediction[14] plays a very critical role[9]. Empirical studies of measured traffic traces have led to the wide recognition of self-similarity in wired network traffic[2,3]. Multiclass Ethernet traffic exhibits dependencies over a long range of time scales[1,3]. This is to be contrasted with telephone traffic which is Poisson in its arrival and exponential in departure. In traditional Poisson traffic[16], the short-term fluctuations would average out, when it is integrated over a longer time domain and would come out with a constant mean value. Due to dynamic nature of VANETs many of the previous assumptions upon which ad-hoc systems have been built may no longer be valid in the presence of self-similarity[11]. To analyze the network performance and resource utilization, correct modeling of the network traffic is required. In this work, five different mobility file has been generated and tested. The collected data contains raw data of traffic events occurring among mobile vehicles and RSU. Various characteristics of this large collection of data were estimated to determine packet Inter-arrival time's distribution and time of connectivity of RSU with different vehicles distribution. The self-similar nature of the traffic is also tested. Based on these observations an analytical model for performance measures of a cellular wireless network is also proposed.

2. Simulation Setup

There are three main techniques to analyze the behavior of a system: Analytical Modeling, Computer Simulations and Real Time Physical Measurements. Analytical Modeling may be impossible for complex systems such as the one of this research and Real Time Physical Measurement would require a very long time to be performed and a considerable investment in equipment and resources. Computer Simulation is the only reasonable approach to the quantitative analysis of both traffic and computer networks for this research. The data analyzed in this work were simulated with the help of two simulators namely SUMO and ns2 respectively. The mobility of the vehicles were created with the help of SUMO. Once the mobility pattern is generated, then it is converted into the trace files readable by NS-2 for network traffic simulation. We have generated five different mobility for five different hours. A series of parameters has been fixed for both IEEE 802.11p physical layer (PHY) and medium access control layer (MAC) in order to ensure interoperability between OBU and RSU. The following table shows the default simulation values for IEEE 802.11p between V2I interactions (Table 1). Table 2 shows the trace data of five different simulation results for five different hours.

3. Statistical Tools

3.1 Self-similarity, long-range dependence and heavy-tailed distributions

In this paper, the determination of presence of Self-Similarity and long-range dependence in V2I traffic is stressed by estimating the Hurst Parameter and heavy-tailed ness of the traffic distributions[11]. The Hurst parameter[13] H is a measure of the level of self-similarity of a time series and its long-range dependence.