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List of Publications

[1] M. Vala, and V. Vora, "Information Dissemination Strategies for Safety Applications in VANET: A Review," *in Intelligent Sustainable Systems*, ser. Lecture Notes in Networks and Systems, Springer, Singapore, Aug 2022, vol. 458, pp. 327 – 341.

[2] M. Vala, and V. Vora, "Reliable and Efficient Message Dissemination by Adaptive Relay Selection in Vehicular Networks," *in International Journal of Next-Generation Computing*, 13(3), Oct 2022, pp. 485 – 498.

[3] M. Vala, and V. Vora, "Reliable and Scalable Broadcast Scheme for Safety Applications in Vehicular Ad Hoc Network," *in International Journal of Computer Networks and Applications*, 9(6), Dec 2022, pp. 775 – 784.

Information Dissemination Strategies for Safety Applications in VANET: A Review

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Abstract The intelligent transportation system (ITS) aims to improve the performance of the transportation systems. Vehicular ad hoc networks (VANETs) are the potential mechanism by which ITS can realize its goal. In VANET, moving vehicles form ad hoc networks through wireless connection for exchanging critical information also known as information dissemination. Safety-related information dissemination is multicast or broadcast communication, and it must be fast and reliable. This criterion draws the researchers' focus to develop efficient dissemination schemes. This review paper discusses safety-related message dissemination strategies, along with comprehensive classification, challenges, and future research direction.

Keywords VANET · Ad hoc network · Broadcasting · Multi-hop · Data dissemination

1 Introduction

The ultimate goal of the intelligent transportation system (ITS) is to improve the performance of the transportation systems [8]. Vehicular ad hoc network (VANET) is the key enabling technology by which ITS can realize its goal. The next-generation vehicles are intelligent in the sense that they are equipped with processing and communication technologies. VANET supports the idea of communication among moving vehicles [12]. Moving vehicles form ad hoc networks through wireless connection for exchanging critical information. Such information exchange is called information dissemination.

Standards are developed to govern this kind of communication, and it is known as wireless access in vehicular environment (WAVE). WAVE standards are actually a combination of dedicated short-range communication (DSRC) and IEEE 1609

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Reliable and efficient message dissemination by adaptive relay selection in vehicular networks

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Reliable and timely message reception of an emergency event is the prime objective of emergency message dissemination protocols in vehicular networks. Varying vehicle density and road topologies in vehicular networks raise many challenges for efficient message dissemination. This research paper proposes a new multi-hop message dissemination protocol for emergency events in vehicular networks. It employs a dynamically adaptive relay node selection process that depends on current vehicle density and transmission range. Multi-criteria-based dynamic relay node selection reduces redundant transmission and improves the delay performance of the message dissemination process. The efficient selection of relay vehicles makes the protocol scalable for different operating scenarios. We evaluated the protocol with different vehicle densities and network sizes. Simulation output confirms considerable performance improvements over existing distance-dependent protocols. In urban traffic density scenarios, over 20% improvements are achieved in delay performance to the furthest distance-based protocol with increased reliability and scalability in vehicular networks.

Keywords: VANET, ad hoc network, broadcasting, multi-hop, data dissemination, ITS.

1. INTRODUCTION

As reported in Voelcker [2014], total number of vehicles worldwide will become 2 billion by 2035. Due to increased usage of vehicles, traffics and road accidents are rising day by day. Intelligent transportation system (ITS) is an advanced field that aims to reduce road transportation fatalities and provide infotainment services. ITS considers vehicular ad hoc networks (VANET) as a key enabling technology that has the potential to realize the goals Dimitrakopoulos and Demestichas [2010]. In vanet, vehicles equipped with wireless communication capabilities form a network to exchange messages while moving on the road. IEEE 802.11p standards are designed to govern wireless connectivity among moving vehicles. Physical and MAC layer definitions are provided for radio links in these standards and it is known as Dedicated Short Range Communication (DSRC). Along with DSRC, IEEE 1609.x standards provide upper layer definitions for VANET and the whole protocol stack is collectively known as Wireless Access in Vehicular Environments (WAVE).Eze et al. [2016],Karagiannis et al. [2011].

Successful warning message delivery through vanet can reduce road fatalities by giving sufficient time to drivers, to react against it. To deliver a warning message beyond the transmission range of the sender, multi-hop message dissemination is required. In multi-hop message dissemination, nodes receiving warning messages will further re-broadcast the message to provide full coverage in the network Panichpapiboon and Pattara-Atikom [2011]. The rebroadcasting nodes are typically known as forwarding nodes. Poor choice or a large number of forwarding nodes results in poor network performance. It increases packet collisions due to bandwidth saturation and congestion in networks. Opposite to it, the optimum choice of relay nodes and redundant broadcast suppression provides high coverage with acceptable delay and reliability Wu et al. [2017].

It is observed that vanet suffers from broadcast storm problems, frequent disconnections, and mobility-induced varying channel characteristics Tonguz et al. [2010]. In presence of the above characteristics, the task of sufficient coverage and delay-sensitive requirements is challenging work and it is still an open challenge for designers of the applications. This paper focuses on improving delay performance and net reachability for vanet safety applications. We propose a reliable and efficient adaptive dissemination protocol called AMDP – Adaptive multi-hop dissemination

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RESEARCH ARTICLE

Reliable and Scalable Broadcast Scheme for Safety Applications in Vehicular Ad Hoc Network

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Abstract – In vehicular ad hoc networks (VANETs), safety-related applications require fast and reliable message broadcasting techniques for efficient performance. Reducing redundancy and increasing the reliability of message broadcasts are key challenges amid high mobility, rapidly changing topologies, and shorter communication ranges. The broadcasting protocol needs to be scalable for large variations in vehicle densities and road topologies. This paper presents a new broadcast protocol for safety applications in vehicular networks. The discussed scheme is adaptive to current network loads and channel conditions. Compared with other state-of-the-art protocols in its category, it offers better robustness, coverage, and scalability. It achieves these gains by selecting the next relay node adaptively and effectively suppressing redundant transmission of safety messages. Compared to existing work, the presented protocol offers performance improvements in terms of coverage and delay. It offers a 21% improvement in delay compared to the farthest distance-based protocol.

Index Terms – VANET, Ad Hoc Network, Broadcast, Multi-Hop, ITS, Network Protocol.

1. INTRODUCTION

As per the survey [1], the total vehicle population is increasing day by day and will reach 2 billion by 2035. Usage of automobiles at this scale results in high traffic, low efficiency, and road fatalities. Intelligent transportation system (ITS) is an advanced field that aims to reduce road fatalities and offer other services by implementing the Internet of Vehicles (IoV) [2]. In the IoV, every vehicle establishes communication links with other surrounding vehicles and shares crucial information such as position, speed, and sensor outputs to develop cooperative driving that is more efficient and safer. Wireless access in vehicular environments (WAVE) is the technology developed to establish vehicular communication. It is composed of IEEE 802.11p standards that define physical and medium access layers. It is known as dedicated short-range communication (DSRC). Upper layers of WAVE are defined in IEEE 1609.x standards [3], [4].

The practical range of vehicular communication established through WAVE technology is no more than 300 meters in dense traffic scenarios. Within this distance, only a limited number of vehicles will get the alerts, and the driver's reaction time is less in emergencies [5], [6]. The multi-hop alert broadcast is often used to get rid of this problem and spread alerts over a longer distance.

In a multi-hop scenario, the blind broadcasting of alert messages causes an exponential increase in alert re-broadcast. The network gets flooded with excessive redundant alerts, and the performance of the application deteriorates. To eliminate this situation, a restricted broadcast is used in which a limited number of relay vehicles are selected at every hop to convey the message further [7]. The performance of alert dissemination depends on the optimal selection of relay vehicles. A high number of relay nodes does not solve the problem of redundancy, while a low relay count increases failure chances because of failed links or the unavailability of vehicles. The high mobility, shorter communication range, and rapidly changing topologies result in frequent disconnection and varying channel conditions [8]. Broadcast storms occur when broadcasting on high-density networks. Because of the above-cited special characteristics and limitations, reliable and fast alert dissemination is challenging and still an open challenge for researchers [9].

The main objective of the proposed research work is to improve reliability and the rapid delivery of alert messages for vehicular safety applications. In this paper, we propose a multi-hop dissemination protocol called Efficient and Reliable Adaptive Dissemination Protocol (ERAD). ERAD is a smart dissemination protocol that adapts the delay characteristics to actual network conditions. ERAD attempts to improve the delay characteristics and reliability of alert message propagation without increasing overhead. It eliminates the broadcast storm problems by reducing redundant transmission through effective broadcast suppression mechanisms.