Single-hop Distributed Relay Nodes Selection for Alert Messages Dissemination in VANETs

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***Abstract*— High speed road traffic accidents is a global concern and large efforts are being performed for the reduction of these kind of accidents. Alert messages dissemination protocols using vehicular ad hoc networks (VANETs) have strong potential in reducing high speed accidents by providing early warning to the vehicles about an emergency situation ahead. While designing alert messaging protocols, it is crucial to satisfy reliable messages reception and low end-to-end communication delays. A number of research work proposed alert message dissemination protocols with multi-hop propagation scenario using relay nodes. In these works, symmetric range of communication between vehicles is assumed which is not true, whereas protocols' performance is evaluated while considering non-realistic wireless channel conditions and mobility models. This research proposes a novel alert message dissemination protocol for warning possible endangered vehicles by utilizing single-hop neighboring nodes information. The protocol is expected to improve accuracy of relay nodes selection and increase alert messages reception rate over mobile radio channels. High reliability is expected to be achieved while keeping end-to-end communication delays, data traffic redundancy and bandwidth utilization at accepted levels.**

***Index Terms*— Alert messages, distributed selection, end-to-end delay, message reception reliability, single-hop, VANETs.**

INTRODUCTION

Due to road accidents, over 1.2 million people die per year and as high as 50 million others suffer non-fatal injuries [1]. According to the Decade of Action for Road Safety 2011 - 2020, a global plan is drawn for reduction of road traffic injuries and deaths, where approximately 5 million lives, 50 million serious injuries and an amount of US$ 5 trillion could be saved over this decade [2].

Vehicular Ad-hoc NETworks (VANETs) is a subclass of mobile ad hoc networks (MANETs) that connect cars functioning as nodes in mobile networks. Considerable attention is diverted from various world governments, industries and academic institutions towards the application of VANETs for improving road safety and providing on-road infotainment services [3]. Alert messaging using VANETs have strong potential to reduce high speed road accidents by providing early warning messages to the vehicles approaching dangerous situations ahead [4-6], where a number of alert messages dissemination protocols have been proposed. An application generic messages broadcasting protocol has been proposed, where relay nodes selection are based on estimated transmission range and distance between transmitter and receiver [7]. Distributed alert messages dissemination protocol has been proposed while taking into account the possibility that any two vehicles might not be able to communicate directly with each other due to asymmetric transmission ranges [8].

In this work, we propose a distributed alert messages dissemination protocol which will target improvement of relay nodes selection accuracy and increasing messages reception reliability while only taking into account single-hop neighboring nodes information. Performance will be evaluated over near to realistic mobility models, whereas mobile radio channel and radio obstacle parameters will be considered as well. By improving alert messages reception reliability, we target to simulate the reduction of road traffic accidents over high speed roads, where this service may prove useful especially in reducing highways chain traffic accidents.

PROBLEM STATEMENT

Most research works assume symmetric communication range between vehicles where this is not true due to high mobility, existence of radio obstacles and channel fading effects [7, 9, 10]. Additionally, considerable research works propose the use of random-way mobility model and two-ray channel model, where both models do not properly represent real world traffic and communication channels, respectively.

Research works that identify relay nodes based on localized selection techniques fail to assess surrounding network condition, hence alert messages cannot be configured based on dynamics of the network. Conversely, existing distributed relay nodes selection propose gathering neighboring nodes information at a distance of more than a single-hop, hence depending on intermediate nodes for propagating neighboring nodes information. Whereas, the failure of any intermediate nodes will result into the failure of updated neighboring nodes information collection. Additionally, usage of intermediate nodes can result in increased redundancy overheads.

PROPOSED CONTRIBUTION

We propose a neighbor-knowledge based protocol for safety related information propagation, where the protocol is

based on information gathered from single-hop *Hello* packets. The periodic *Hello* packets would mainly include a unique node ID, node positioning points and a list of currently active communicating nodes that an underlying node can listen to directly and sustainably. It is assumed that each cars will be equipped with positioning device and IEEE 802.11transceiver.

A proper selection of relay nodes is crucial in design of alert messaging systems in VANETs. The right choices of relay nodes would mainly govern reliability of received messages, overall end-to-end communication delays and bandwidth usage efficiency. The proposed protocol consist of a dynamic and explicit relay node selection algorithm for forwarding alert messages in multi-hop propagation scenario, but while considering single-hop assessment of neighboring vehicles. If any two neighboring vehicles are capable of communicating directly and sustainably, we term them as coupled. The core idea of proposed relay node selection is to find preceding nodes having bi-directional and sustainable communication with the underlying node while only using single-hop information exchange. Fig. 1 presents a coupling communication scenario of node N with L, T, D and C.

A flowchart elaborating a generalized table buildup process is shown in Fig. 2, where records entry process in nodes coupling table is performed between a pair of vehicles. As can be seen from this flowchart, the end decision after receiving a periodic single-hop *Hello* message is to either add-up the transmitting vehicle as a coupled node or not to add it up.

EXPECTED OUTCOMES

Performance improvements within a system usually follow a trade-off mechanism between system parameters. Our main focus is in improving reliability of alert messages reception while maintaining a reasonable amount of low end-to-end delay. Compared to previous works, the proposed protocol is expected to provide more reliable alert message reception rate and more accurate relay nodes selection while considering more realistic mobility and channel models. Conversely, there might be an increase in end-to-end communication delays due to reliance on single-hop communication, but if achieved delays are under threshold value specified for alert message, then the achieved system's performance would be acceptable.

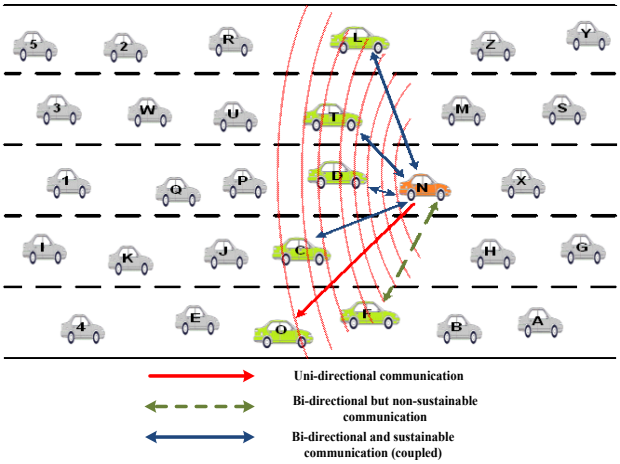

Fig. 1. Nodes coupling communication scenario

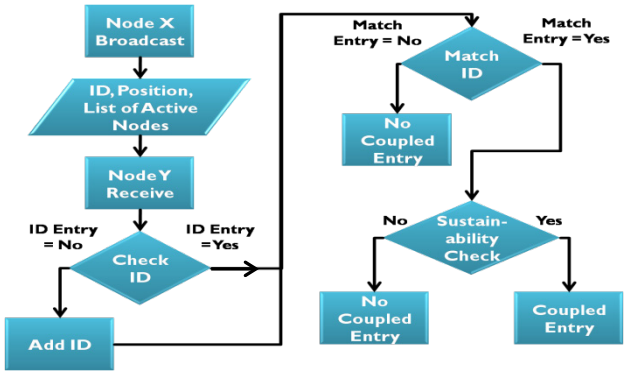

Fig. 2. Nodes coupling flowchart

CONCLUSIONS

In this work, we propose a distributed alert message dissemination protocols, where a relay node selection algorithm selects the most suitable node for re-broadcasting the alert messages. The protocols is a single-hop neighbor knowledge based protocols where a number of neighboring nodes information are received by each vehicles in a periodic manner. With the application of this protocol, more accurate relay nodes selection and improved alert message reception rate is expected at low end-to-end communication delays.

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