An Efficient Scheme for Reliable File Transfer using Residual Link Lifetime Estimation based on Sparse Vehicular Routes

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Abstract. Location based networking protocols in Vehicle Ad-Hoc Networks (VANETs) employ the hopping strategy to acquire the route to a destination node. One of the commonly used methods is to select the vehicle that is nearest to their destination. This greedy transmission approach leads to packet drop in disruptive networks like VANETs, since it doesn't take account of the quality of the newly-established links. In this article, a new method is proposed for identifying the next-hop node from a potential set which takes account of the remaining life of the contact connections combined with the vehicular movement. Compared with the existing idea of predicting the new location using Kalman filters, the proposed method is based on vehicular density in the path to destination.

1. Introduction

1.1. VANets

Ad-hoc network setup between vehicles, popularly known as VANets is a form of MANET in the vehicle domain. VANets were initially identified for applications involving "car to car networking" to relay information between vehicles. Connectivity architecture for buses, vehicles, highways, and other roadside facilities has been shown to coexist in VANets. VANets are an integral part of the design of Smart Transport Networks. VANets are also known as smart transport networks. Vehicular networking was envisioned to establish a novel kind of networking paradigm to provide cost-effective and effective data delivery for vehicular communications [9]. Vehicle contacts can be utilized to decrease road injuries, traffic congestion, travel time, fuel consumption, etc. VANET is used by Intelligent Transportation Systems (ITS) to enhance a varied range of other commercial services as well. To perform V2I and V2V communications, VANets take advantage of Road-Side Units (RSUs) and On-Board Units (OBUs). On the roadsides, RSUs are installed, while on buses, OBUs are installed. Vehicle traffic congestion is one of the big vehicle traffic problems that this has gained widespread interest in the field of VANet study. Congestion occurs on the networks as the network channels are saturated by the nodes competing to obtain the networks. Indeed, the number of channel collisions raises the frequency of network congestion by raising the density of vehicles. The incidence of congestion increases the delay and loss of packets (especially for safety messages. This leads to mitigation of the VANets' production. Control of Congestion is an effective way to help the QoS that should be employed. The delay and packet loss and thus the efficiency of VANet can be improved by controlling the congestion to help provide a better and more secure environment.

One of the principles where cars share information with each other about congestion or hazardous conditions is through a distributed traffic information update system [8]. One of the troublesome
problems with VANets is data congestion. In high density network conditions, congestion occurs in the system when the channels are overloaded, leading to increased packet delay and packet loss and also reducing network performance.

1.2. Objectives of VANets

The present work suggested in this paper, is a method to increase the efficiency of communication links along the path from source to destination nodes. It aims for the selection of better next hop forwarding nodes. In the proposed design, the node for the packet carrying vehicle (i.e. the source vehicle) selects the forwarding vehicle from a given range of applicant vehicles by measuring the lifetime of the residual link of the respective individual communication links. The current work presents an algorithm for calculating the residual link lifetime of the next-hop nodes in VANETs. The suggested method is determined based on the relative position and speed of the nodes in the car. A vehicle belonging to the forwarding range resulting in a maximum residual connection lifetime value shall be chosen as the forwarding vehicle before all probable one-stop connections are available for the measured residual connection lifetime.

The topology of the network is extremely complicated since the nodes in VANETs move at a very high speed. Thus it makes the inter-vehicle contact connections very unreliable [6]. Hence, it is very important to select an ideal path consisting of strongly connected nodes.

2. Related work

The work suggested in [1] is a system based on Edge devices to offload vehicular data. Thus, every vehicle communicates its content to the Edge servers regularly. That's because a Vehicle - to - vehicle multi-hop route is more unpredictable as the route becomes wider. MEC server gathers recorded contexts from automobiles, and afterwards uses the recommended offloading route. The performance evaluation has been shown that suggested MEC assisted offloading is superior in various vehicle densities than the conventional VANET offloading procedure. The user-initiated messaging systems in vehicular networks are evaluated to analyse the impact of mobility on E2E delays in [2]. Two schemes that were evaluated and analysed were the longest distance-based forwarding and link signal quality-based next hop forwarding method.

The studied schemes efficiently use wireless channel transmissions. As in [3], a network full of user-data and beacons leads to floods that contribute to an irrelevant use of energy. To cope with such problems, the idea is to alert vehicles of a smaller-range by means of FUZZY Beacon-less stochastic broadcast method. The strategy of recipient-oriented transmission is calculated based on data-size, angular inclination, direction of travel and cache loading delays. As in [4], a hybrid framework is suggested which tries, across various vehicular densities, traffic patterns and transit contexts, to improve the message delivery performance of VANETs. The suggested approach in [5] defines an effective data path by taking into account both the travelling paths of the target vehicle as well as the propagation path including its data in order to distribute data to an appropriate receiving point. It also offers trajectory-dependent transfer and reconfiguration based on data logging, to respond to adjustments in path in the target vehicle caused a shift in travel speed and course. The schemes discussed need to estimate the channel access levels before send a file. In the next section we address the next hop selection using both residual link lifetime and one hop latency to deliver a message to the forwarding node [6].

3. Problem formulation & System model

3.1. Problem statement

By choosing the next hop forwarding node as the vehicle closest to the destination, regional routing protocols in Vehicular Ad Hoc Networks (VANets) rely on a greedy hop-by-hop packet forwarding technique. However in VANET, because this is a thickly mobile network, the strategy being greedy
will lead to packet broadcast failure because when next hop forwarding nodes are chosen, the stability of the newly formed link is not considered. The newly suggested procedure for next hop selection takes into account the residual lifetime of the communicating nodes. By using speed, location, time and hop latency in VANets, we measure the linked residual lifetime.

3.2. Proposed work
We define the method for selecting the next-hop forwarding vehicle in this segment, which relies on using the residual lifetime of the connection. We begin this part by presenting the model of the system used in the article and then specifying the lifetime of the residual link.

3.3. System model
The system under analysis is a one in where vehicles travel on a straight-line highway and the driver will drive independently of other moving vehicles. In addition, we suppose that all cars will be heading in the same path as seen in Figure 1. For the study of residual lifetime, effective transmission range is under consideration.

![Figure 1. Highway scenario considered](image)

4. System analysis
4.1. Problems with Existing System
Current schemes for file transfer rely primarily on forecasting and calculating the lifetime of the relation through implementing a kalman filter. We introduce a model to use the Residual Link Lifetime and one-hop latency in VANETs instead of only residual link lifetime [7]. A vehicle subscribing to the routing set that ends in an optimum amount for the remaining life of the connection is chosen as the routing vehicle. The communication network is incredibly complex since VANET nodes (i.e. vehicles with on-board components) run at a very high speed, so inter-vehicle links are particularly unstable or can even be disrupted on a daily basis. A route established between a source and destination pair through a specific sequence of roadway sections will appear to be inaccurate if at least any communication link across the route drops. It is therefore very necessary and appealing to select an appropriate path for the distributed protocol comprising of highly safe network connections. The test results show that the proposed strategy significantly improves the packet propagation ratio.
4.2. System design
This section displays the full details of the design of the proposed system. This chapter further illustrates the algorithm and the operating method. We define the suggested approach for next-hop selection criteria in this subsection. To know their location and distance, it is assumed that all vehicles have GPS equipment. Each vehicle emits a beacon for some specific period of time providing information on its location coordinates and rate of movement. A vehicle will collect the measured values from each adjacent node from the beacon message. Upon receiving a beacon message, the vehicle will perform a one-step forward prediction to determine the residual link lifetime of the related link. The tagged vehicle then forms the list of neighbours by adding all one-hop neighbours, their IDs and the remaining link lifetime of the respective one-hop neighbour link (in figure 2.).

In view of the high vehicle velocity, wireless channel instability pertains. The minimum lifetime of the link between a node and its neighbours is determined by the time at which the next beacon is sent, using an estimation scheme for the availability of the link between two nodes. This is based on the observation that vehicles driving at the same speed can be viewed as going in a platoon and are more likely to stay attached for a significant amount of time. On the other hand, vehicles operating at reasonably high speeds have frequent failure encounters that enable beacon signals to be transmitted more easily. The link lifetime (LLT) is obtained between two adjacent i and j cars moving in the same direction,

\[
LLT = \begin{cases} 
\frac{2R-d_{ij}}{|V_i-V_j|} & \text{if } V_i > V_j \\
R-d_{ij} & \text{if } V_j > V_i 
\end{cases}
\]

where range of transmission is R, Vehicle velocities are Vi and Vj for i and j vehicles, and |Vi-Vj| is the measured Euclidean distance separating the vehicles. A node for which we need to calculate the LLT selects its neighbouring nodes by sending a new beacon for the adjacent vehicles. As a result, nodes with faster movements across their nearby vehicle set will have larger beacon transmission rates and will be much more likely to leave the transmitting nodes contact reach in a shorter amount of time. For a lesser duration, there is indeed a need to modify the local configuration.
5. Simulation Setup
To measure the system performance, two different types of network simulator has been used. For the simulation process of mobility of vehicle, we used Simulation of Urban Mobility (SUMO). The OMNET++ 4.6 implementation was used for the VANets. To test the suggested approach, a highway road sample is taken into account. The communication procedure for MAC transmission layer strategy was considered to be IEEE 802.11p. The parameters used to consider the proposed methodology are tabulated in Table 1.
Table 1. Simulation Parameters used in Highway Scenario.

| Parameters       | Values         |
|------------------|----------------|
| Road Length      | 3 Kilo meters  |
| Total no. of Lanes | 4 lanes      |
| Vehicles Speed   | 0-25 m/sec    |
| Transmission Rate| 3-27 Mbps     |
| Transmission Range| 300 meters  |
| Each message size | 1024 Bytes   |
| MAC Type         | IEEE 802.11p  |

6. Results and discussions

Figure 3 shows the end-to-end delay average for various beacon arrival time values. The average end-to-end delay measured lesser than the value obtained using kalman filter method. If the beacon period increases, the end-to-end delay increases due to the rise in inaccuracy of prediction. Around the same time, because of the higher number of hops to the destination in the first example, the recommended approach leads to greater latency relative to greedy forwarding. From the results we conclude that only nodes that had a higher measure value of RLLT were considered as forwarding node.
In figure 4, the packet delivery ratio comparison is shown. As the beacon period increases, the packet delivery ratio decreases due to the growth in forecast inaccuracy. As can be seen the proposed method proves better than the prediction method.

Figure 4. Comparison of Packet Delivery Ratio

Figure 5. Comparison of RLLT and non RLLT Approach
In Figure 5, Residual Link Lifetime (RLLT) approach shows better results when compared to Non RLLT approach.

7. Conclusion
In this work a novel scheme focused on awareness of residual relationship lifetime over the next hop link alternative was implemented. Pace of vehicles was presumed. It has since established an approach for calculating residual connection lifetime using range, pace, position and hop-latency. The recommended next hop discovery approach ensures that for links with the most residual link lifetime are used for data forwarding. From comprehensive simulated data, we showed that the proposed algorithm is better than the existing greedy forwarding approach.

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