A Fast Reroute Algorithm for Infotainment Service in Internet of Vehicles

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ABSTRACT

Failure recovery in Internet of Vehicles (IoVs) is critical to high quality service provisioning. The main challenge is how to achieve fast rerouting without introducing high complexity and resource usage due to the dynamic topology and the constraints on bandwidth. In this paper, we propose a traffic prediction-based fast reroute algorithm for use among the vehicles in IoVs. The proposed algorithm uses the Wavelet Neural Network (WNN) model to predict a vehicle’s network traffic. When the predicted value is greater than the predefined network traffic threshold, both Adaptive Retransmission Trigger (ART) that contributes to switch to a better alternate path in advance and trigger efficient retransmission behaviors are enabled successively. Performance comparison of our proposed algorithm with Ant-based Delay-Sensitive Vehicular Routing (AntVehiNet) shows that WNNPFR can: (a) maximize the service data delivery rate by load balancing, (b) provide high quality of service delivery for multimedia streams by switching to a better path towards a target node in advance, (c) reduce useless data retransmissions when various network failures occur, and (d) maintain lower routing overhead.

KEYWORDS

Fast Reroute, Infotainment, Internet of Vehicles, Quality of Service, Wavelet Neural Network

1. INTRODUCTION

Vehicular ad-hoc networks (VANETs) originated from Mobile Ad-hoc Network (MANET) has been under research for many years. Internet of Vehicles (IoVs) can be seen as a superset of VANET. It extends VANET’s scale, structure and applications. Its goal is to make people enjoy infotainment service easily, and to improve the travel comfort. Infotainment service includes the video on demand, the voice talk, and the message exchange. It is worth to note that the stringent quality of service requirements of multimedia streams delivery, such as (1) the end-to-end delay, (2) the packet delivery rate, and (3) the PSNR (peak signal-to-noise ratio) level. However, the network topology over IoVs is dynamic and the communications among nodes are not stable, which result in infotainment service interruption. Hence, the routing algorithms for IoVs are frequently unavailable. Three recent surveys (Cheng, et al., 2015; Li, et al., 2014; Zhang, et al. 2012) on current trends and future directions about routing in IoVs show that to overcome various failures over IoVs, such as node failures, link breaks, network congestion, and dynamic holes, rerouting has responsibility of choosing an alternate path that is not optimal to continually deliver the multimedia streams and guarantees quality of service of data delivery. Nowadays, more rerouting algorithm explorations are required to adapt to dynamic topology caused by various failures and guarantee the quality of infotainment service delivery.
The efficient rerouting algorithm needs a stable and connected network topology environment. The survey (Jia, et al, 2015) describes a platoon-based vehicular networks. In the platoon-based vehicular model, one vehicle follows another, and it maintains a small and nearly constant distance to the preceding vehicle. It has been proved that, such the platoon-based vehicular networks model can significantly divide the IoVs into multiple smaller stable and connected clusters and provide the reliable transmission environment.

This paper proposes a Wavelet Neural Network Prediction-based Fast Rerouting (WNNPFR) algorithm for use among the vehicles within clusters. According to the literature (Li & Boukhatem, 2013), the multipath routing among the vehicles is discovered. And then, we use Wavelet Neural Network(WNN) model to predict the vehicle’s network traffic. When the predicted value is greater than the predefined network traffic threshold, both Adaptive Retransmission Trigger (ART) that contributes to switch to the better alternate path and trigger efficient retransmission behaviors are enabled. In consequence, this failure area is smoothly bypassed and multimedia streams are continually forwarded to the destination node. Finally, WNNPFR is implemented on the Opportunistic Networks Emulation (ONE) platform. Compared with the homogeneous algorithms, WNNPFR can significantly improve the quality of service data transmission. Moreover, WNNPFR has lower end-to-end delay and communication overhead, and higher packet delivery rate.

The rest of the paper is organized as the following: Section 2 introduces an overview of existing related works. Section 3 provides the network architecture and the system model. Section 4 presents the wavelet neural network prediction-based fast reroute algorithm. Section 5 presents the performance evaluation. Finally, Section 6 concludes the paper.

2. RELATED WORK

Routing protocols is an important research aspect in IoVs. Next, we provide a taxonomy on routing protocols in IoVs based on delay tolerance and delay sensitivity. And we summarize them in Table 1.

1. Delay-Tolerant: Delay-tolerant networks (DTNs) can deal with the cases with occasional lack of connectivity, and thus often use a carry and forward mechanism. Their representative is GeoSpray (Soares, et al., 2014),which combines a hybrid approach between multiple-copy and single-copy schemes to make routing decisions based on geographical location. The former is started in the beginning, and the latter is activated when GeoSpray finds alternative paths. It is

<table>
<thead>
<tr>
<th>Routing Protocol</th>
<th>Routing Type</th>
<th>Delay Sensitivity</th>
<th>Information Used</th>
<th>Rerouting</th>
<th>Performance Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeoSpray (Soares, et al., 2014)</td>
<td>Unicast</td>
<td>Delay Tolerant</td>
<td>Position-based</td>
<td>No</td>
<td>Transmission delay/delivery ratio</td>
</tr>
<tr>
<td>Spray and Wait (Spyropoulos, et al., 2008)</td>
<td>Unicast</td>
<td>Delay Tolerant</td>
<td>Position-based</td>
<td>No</td>
<td>Transmission Delay/delivery ratio</td>
</tr>
<tr>
<td>AntVehiNet (Li &amp; Boukhatem, 2013)</td>
<td>Unicast</td>
<td>Delay Sensitive</td>
<td>Map-based</td>
<td>No</td>
<td>Transmission Delay/delivery ratio/overhead</td>
</tr>
<tr>
<td>RLI (Wang, et al., 2015)</td>
<td>Unicast</td>
<td>Delay Sensitive</td>
<td>Position-based</td>
<td>Yes</td>
<td>Transmission Delay/rerouting delay/overhead</td>
</tr>
</tbody>
</table>
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