Routing Protocol Design and Implementation for a Vehicular Ad-Hoc Network (VANET)

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Introduction

Vehicular Ad-Hoc Networks (VANETs) rely on routing protocols to disseminate traffic information efficiently and effectively throughout the network. In this study, we examined the performance of the Subzone routing protocol using realistic traffic models and empirical highway traffic data. We developed probability models and used them to test parameter settings within the protocol. Based on the results, we constructed a model that optimizes the Subzone protocol for different circumstances. To begin the implementation of the Subzone protocol, we designed a software framework that is capable of carrying out the basic logical operations of the Subzone protocol and tested the framework on portable nodes.

The Subzone Protocol

The Subzone Protocol works as follow:

- An emergency message is broadcasted from the yellow vehicle. Ideally, it is desired that this message propagates as far back as possible.
- Each vehicle receiving the message determines its zone based on its distance from the yellow vehicle. Each zone has an associate delay time in which the vehicles wait before re-broadcasting the message.
- If a rebroadcast is heard, every vehicle turns off its delay and cancel it rebroadcast schedule.

Optimization Process using probability models

In this protocol, the number of zones determines the efficiency of the message propagation. In order to effectively determine the optimum number of zones, we developed probability models which account for various settings, such as traffic density and transmission range. The process is shown below.

1. Generate Random Inter-Vehicular Spacing based on exponential distribution, which is controlled by the traffic density.
2. Dropped packet probability using Log-normal power law model.
3. Use the generated traffic data to examine the following protocol parameters:
   - Expected delay per hop vs. number of zones
   - Expected distance per hop vs. number of zones
   - Average delay/distance vs. number of zones
4. Optimize the Subzone Routing Protocol for varying traffic densities

Conclusion

Using empirical traffic data, a thorough analysis of the Subzone Routing Protocol was conducted to optimize routing efficiency in a sparse VANET. Furthermore, a software framework has been proposed and implemented into routing scenarios. Although the implementation was limited by hardware constraints, the results verified that the basic logic was realized.

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References


Software Framework Test

We tested the software framework by creating traffic scenarios using 4 pre-arranged nodes. Each node consisted of an embedded wireless transceiver (Moteino), GPS receiver module (Parallax), and the software framework, as seen below.

Nodal Arrangement #1

Nodal Arrangement #2

Packet Structure

<table>
<thead>
<tr>
<th>PREAMBLE (3)</th>
<th>SYN (2)</th>
<th>HEADER (4)</th>
<th>DATA (28 bytes)</th>
<th>CRC (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handled by Hardware</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We programmed each node using the proposed software framework. Each node logged the transmitted data, which was triggered by the push of a push button, and the received data. We would ultimately use these data logs to analyze the behavior of the nodal network after the tests were run. The results for each nodal arrangement are seen below.

Step 1

Step 2

Step 3

Step 4