On the Evaluation of Caching in Vehicular Information Systems

Nicholas Loulloudes, George Pallis, Marios D. Dikaiakos
Department of Computer Science, University of Cyprus
{loulloudes.n, gpaillis, mdd} @ cs.ucy.ac.cy
http://grid.ucy.ac.cy/vanets

Vehicular Information Systems

Provide services to vehicles such as:
- Road information (Traffic conditions, availability of road-side facilities, etc)
- Warnings (Hazardous condition, avoidance measures, etc)

Our Approach

Enable Caching Support in VITP - Peers cache the most recent information they sense - Introduce Cache – Control Headers which act as directives to VITP peer caching decisions

Vehicular Information Transfer Protocol (VITP)

A pro-active, location-aware, application layer communication protocol for Vehicular Computing

VIS put significant overhead to the VANET services
1) Saturation of limited network resources
2) Degradation in the quality of VANET services

Motivation

“To Cache or Not to Cache Vehicular Information in VANETs?”

Cache Control Directives Used in VITP Messages

<table>
<thead>
<tr>
<th>Directive</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cacheable</td>
<td>Boolean</td>
<td>The reply can be cached</td>
</tr>
<tr>
<td>Expires</td>
<td>Time-stamp</td>
<td>The time after the reply is considered expired (if cached)</td>
</tr>
<tr>
<td>Public</td>
<td>Boolean</td>
<td>The cached reply can be reused by any peer</td>
</tr>
<tr>
<td>Retransmit</td>
<td>Boolean</td>
<td>Serve incoming request first from cache and retransmit it to target area also.</td>
</tr>
</tbody>
</table>

* There are 4 additional directives not illustrated here.

Network Simulation Test Bed

- Network simulator: ns-2.33
- Wireless interface: 802.11b
- NS2 Internal Time model used
- Nodes: 970 Region 1 / 875 Region 2

Examined Metrics

- Query Recall: the number of replies received while issuing queries towards a specific location of interest over the number of replies that should have been received
- Information Accuracy: how close the received value describing some information is to the actual value
- Response Time: average Round Trip Time in seconds of a successful VITP transaction
- Number of Exchanged Messages: total number of exchanged messages, including routing messages and VITP messages

Evaluation Results

- Cache-enabled VITP improves Response Time up to 31%
- Cache-enabled VITP can maintain high levels of accuracy; up to 83%
- Query recall increases as TTL increases since more queries are resolved from the cache
- Network overhead is reduced up to 27%

Vehicular Mobility Generation: Simulated traffic in two real cities with different topological layouts. Mobility traces were generated using Traffic Modeller and SUMO. Accurate city maps obtained through OpenStreetMap.org