Simulation of Information Propagation for Vehicles in Physical Communication Network Models

SAINT2004 - Service Oriented Computing Workshop
Tokyo, Japan
Monday, 26 January 2004

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Presentation Outline

- Motivation
- Characteristics of motor vehicles
- Physical communication network models
- Simulation
- Results and discussions
- Summary and future work
Motivation

- **Background**
  - Important to propagate information or software to vehicle users **rapidly**

- **Early studies**
  - Web bulletin board
  - Information broadcasting via e-mail
  - Peer-to-Peer

- **In this study**
  - Communication network models
  - Rapid information propagation for vehicles
  - Characteristics of models
Characteristics of motor vehicles

- **Operation time of vehicles**
  - Depends on usage
    - Commuting, shopping, commercial using

- **Mobility of vehicles**
  - Depends on purpose
    - Long-distance transport, local bus transfer

- **Density of vehicles**
  - Depends on time or situation
    - Day or night, traffic jam
    - Urban or rural area
Physical communication network models

- Wide Area Wireless Communications
- Dedicated Short Range Communications
- Vehicle to Vehicle Communications
- Hybrid Communication model
Wide Area Wireless Communications

Communication speed: 2Mbps
E.g. 3G mobile phone network

In use

Communication area

Cellular phone antenna

Server

Non used
Physical communication network models

**Dedicated Short Range Communications**

Communication speed: 10Mbps

*Example: wireless network*

**Diagram:**
- Server
- DSRC antenna
- Communication area
- (Wireless LAN station)
- Non used
- In use
Physical communication network models

Vehicle to Vehicle Communications

Communication speed: 10Mbps
e.g. wireless network

Non used
In use
Communication area
Physical communication network models

Hybrid Communication model

e.g. "Vehicle to Vehicle" & "Dedicated Short Range" - Communications
Net simulation

- Configuration
- Assumption
- Demonstration
Simulation of Information Propagation for Vehicles in Physical Communication Network Models

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Net simulation

Configuration

- 2 areas
  - 400 cells

Communication area

- "Vehicle in use"-node
- Road-cell
- Building-cell

Vehicle nodes:
- can only exist in road cell
- move randomly on road cell
- can only turn at a cross road

DSRC antenna
(e.g. wireless LAN, DSRC)

"Vehicle non used"-node

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## Assumption

<table>
<thead>
<tr>
<th></th>
<th>Communications</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wide Area Wireless</td>
<td>Dedicated Short Range</td>
<td>Vehicle to Vehicle</td>
</tr>
<tr>
<td>Node holding information a priori</td>
<td>1 node</td>
<td>16 nodes</td>
<td>1 node</td>
</tr>
<tr>
<td>Maximum simultaneous connections</td>
<td>250 nodes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication bandwidth</td>
<td>2 Mbps</td>
<td>10 Mbps</td>
<td>10 Mbps</td>
</tr>
<tr>
<td>Communication area</td>
<td>Whole area</td>
<td>Area around antenna (20x20 cells)</td>
<td>Area around vehicle (20x20 cells)</td>
</tr>
</tbody>
</table>
Simulation Demonstration

Hybrid Communication model

Pink point: Vehicle holding information

Green point: Vehicle not holding information

Area in red: Communication area of DSRC
Results and discussions

Basic-simulation results
- Operation time of vehicles
  - Rate of operation time per day
- Mobility of vehicles
  - Mobility rate
- Density of vehicles
  - Number of nodes

Applied-simulation result
- Urban area
Result and discussion: Basic simulation results

Operation time of vehicles

Vehicle to Vehicle Communications

Parameter: rate of operation time per day

90% 100%

Strong influence
Result and discussion: Basic simulation results

Mobility of vehicles

Vehicle to Vehicle Communications
Parameter: mobility rate

No influence
Result and discussion: Basic simulation results

Density of vehicles

Vehicle to Vehicle Communications

Parameter: number of nodes

90%

Heavy influence

Density graphs showing rate of propagation versus time of propagation. The graph indicates a heavy influence at 15,000 nodes with 90% density, and a notable effect at 1,500 nodes.
Result and discussion: Applied simulation result

Urban area

Assumptions

Number of nodes: 15,000

Parameter

<table>
<thead>
<tr>
<th>Nodes type</th>
<th>Rate of operation time per day</th>
<th>Rate of mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxi</td>
<td>60 %</td>
<td>50 %</td>
</tr>
<tr>
<td>Truck</td>
<td>60 %</td>
<td>90 %</td>
</tr>
<tr>
<td>Commercial vehicle</td>
<td>40 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Private car</td>
<td>5 %</td>
<td>20 %</td>
</tr>
</tbody>
</table>

Distribution of node types:
- Private car: 82%
- Commercial vehicle: 12%
- Truck: 5%
- Taxi: 1%
Result and discussion: Applied simulation result

Urban area

Communication network models:
- Wide Area Wireless Communications (WAWC)
- Vehicle to Vehicle Communications (V2VC)
- Hybrid Communication model (HC)

Rate of propagation: 90%

Results:
- HC is fastest
- V2VC is approximately same as others

Time of propagation (x10)

<table>
<thead>
<tr>
<th></th>
<th>WAWC</th>
<th>V2VC</th>
<th>HC</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WAWC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Time of propagation: 230 250 210
Summary and future work

Summary

- Communication network models
  - Rapid information propagation for vehicles

- Basic simulation results: Vehicle to Vehicle
  - Operation time and density of vehicles: INFLUENCE
  - Mobility of vehicles: NO INFLUENCE

- Applied simulation results: urban area
  - Hybrid is fastest
  - Vehicle to Vehicle is approximately same as others

Future work

- Rural area
Thank you for your attention