Simulative Identification of Possibilities and Impacts of V2X-Communication

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Motivation

Vehicle-Vehicle-Communication

Vehicle-Center-Communication

Vehicle-Infrastructure-Communication

- WLAN, DSRC
- GPRS, UMTS
- DAB, FM
- ...

Center-Infrastructure-Communication
Motivation

- What kinds of applications are thinkable?
- What are the most efficient algorithms - thresholds?

  ➔ Simulation as a development assistance

- Required penetration rates?
- What are the impacts?
  - on traffic flow
  - traffic safety
  - environment, fuel consumption
  - data quality

  ➔ Simulation as an analysis assistance

- Cost-Benefit-Analysis to assist investment decision
Simulative Approach - Architecture

V2X-Application

- get_position()
- get_speed()
- set_speed()
- setDesiredSpeed()
- get_lane()
- setDesiredLane()
- ...

Send (vehicle, message)
Receive (vehicles, messages)

VISSIM

Vehicles within transmission range of sending vehicles

VCom.dll

Chair of Traffic Engineering and Control
Univ.-Prof. Dr.-Ing. Fritz Busch

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Simulative Approach - Communication

Main Requirement:
Scalability: scenarios that are interesting easily comprise a few ten thousands of vehicles over tens of hundreds of kilometers.

Beaconing
Number of scheduled events in NS-2 in dependency of the number of vehicles and of the traffic density.
All scenarios ran 100s and each node broadcasted a single 500-byte packet each second.

⇒ Modeling the communication instead of simulating
Simulative Approach - Communication

Probabilities of packet receptions

Comparison of probabilities of packet receptions depending on the distance between sender and receiver and varying traffic densities

Stochastic modeling of packet receptions with VCOM.dll
Simulative Approach - Interaction

VISSIM

VISSIM step $i$

<table>
<thead>
<tr>
<th>pass control</th>
</tr>
</thead>
</table>

Application

next reception at?

<table>
<thead>
<tr>
<th>send message</th>
</tr>
</thead>
<tbody>
<tr>
<td>receive message</td>
</tr>
<tr>
<td>send message</td>
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</table>

VCOM

VISSIM step $(i+1)$

<table>
<thead>
<tr>
<th>return control</th>
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Simulative Approach – Application Example

- per time step: send current speed limit to all veh.
- per second: data collection by vehicle data (v, q – per lane)
- per 30 seconds: data aggregation
  lane (v, q), cross section (V, Q), section (D)

If congestion is detected: virtual speed funnel:

- \( V_{zul} [RSU] = 60 \text{ km/h} \)
- \( V_{zul} [RSU - 1] = 70 \text{ km/h} \)
- \( V_{zul} [RSU - 2] = 80 \text{ km/h} \)
- \( V_{zul} [RSU - 3] = 90 \text{ km/h} \)
- \( V_{zul} [RSU - 4] = 100 \text{ km/h} \)
Simulative Approach – Application Example

Congestion/Hazard detection:
- Everywhere
- Faster

Congestion/Hazard Warning:
- Everywhere
- Faster
- More Adaptive
without any traffic control
Conventional Dynamic Traffic Control

Delay times:
- 5 % veh*hours
- 10 % veh*hours
- 10 % veh*hours
- 26 % veh*hours

compared to reference scenario without any traffic control
Conventional Dynamic Traffic Control

Delay times:
- 5 % veh*hours
- 10 % veh*hours
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- 26 % veh*hours

compared to reference scenario without any traffic control
How can V2X help?

Processes driving a vehicle

- Road other road users
- Road environment
- Driving strategy

Situation

Perception

Subjective terms of reference

Psychological and physical state of the driver

Subjective terms of reference

Driving of a vehicle

Actions

[Based on Todoskoff et al., 1996]

What are the impacts of
- driver warning?
- driver information?

depending on the current v2x penetration rate

How do drivers react on advanced In-Vehicle Information Systems?
Conclusions & future prospects

- Large-scale v2x-scenarios can be tested and analyzed using this approach to assist investment decisions.
- Potentials concerning the simulation of traffic safety aspects.
- We need to learn more about tactical driving and driver reactions on information and warning.
Questions?

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Citation