Performance measures for cooperative systems – the eCoMove approach

Stefan Trommer (DLR – Institute of Transport Research)
Outline

- Introduction to the eCoMove project
- eCoMove assessment concept
- Performance indicators for validation and assessment
- Methods for validation and assessment of the eCoMove system
The eCoMove project

- 33 partners from 10 countries:
  - Vehicle and supplier industry
  - Map makers
  - Telecom
  - Infrastructure operators
  - R&D labs & universities

- Starting date: 04/2010  Duration 36 Months
- Coordinator: ERTICO ITS Europe
Project goal

To develop a combination of cooperative systems and tools using V2V and V2I communication to help:
• drivers sustainably eliminate unnecessary fuel consumption;
• fleet managers manage their vehicles more economically and promote eco-driving through feedback & incentives;
• road operators balance traffic flows in the most energy efficient way.

Target: reduce fuel consumption and therefore CO₂ emissions of road transport by 20%
Vision and motivation

Wasted energy due to:
- Inefficient deceleration
- Wrong gear & engine speed
- Excessive speed, acceleration
- Poor anticipation
- Poorly synchronised signals
- Choice of inefficient routes

Energy consumption of a “perfect eco-driver”

eCoMove Solutions
- ecoSmartDriving
- ecoFreight & Logistics
- ecoTrafficManagement + Control

Residual wasted energy

Energy consumption of a “perfect eco-driver”

Time

Situation today

The future
Main activities

Develop eCoMove core technologies

- V2X communication platform based on CVIS & SAFESPOT results
- ecoMessage – standardised cooperative messages for energy efficiency-relevant information exchange
- ecoMap – digital map database enhanced with eco-relevant attributes

Develop eCoMove applications

- ecoSmartDriving applications – fuel-efficient driving performance
- eco Freight & Logistics applications – green freight routing and fuel consumption- optimised logistics
- ecoTrafficManagement & Control applications – energy-efficient traffic control & management measures

Validation and impact assessment of eCoMove applications

- Validation and assessment in field trials and simulation
Research questions to answer

1. To what extent can eCoMove decrease the fuel consumption and therefore also CO₂ emissions with cooperative technologies?
2. How can eCoMove sustainably change the performance of private and professional drivers into a more eco-friendly driving style?
3. What impact have eCoMove solutions in a cooperative environment for the traffic system?
eCoMove Validation Plan

• Based on the FESTA V-Modell

• Challenges:
  – Many applications that need to be assessed, separately and combined
  – No FOT – validation of many applications using different methods
Assessment concept

- **eCoMove applications for cars, trucks and traffic management**
- **Field trials** (Munich, Helmond, Torino)
  - Improved driver performance
- **Driving simulator studies**
  - Improved driver performance
- **Microscopic traffic network simulation** (Munich, Helmond, French motorways)
  - Assessment of the eCoMove system (network simulation of Munich, Helmond & French motorways)
  - Assessment of the eCoMove system using traffic simulation models and emission models. Qualitative assessment of long term effects.
  - Integration of findings from field trials and driving simulator studies into the traffic simulation model for following system assessment
  - Individual assessment of applications using different methods

System assessment

Application assessment
Validation categories & performance indicators

- **Environment**
  - fuel consumption, CO$_2$ emissions (in total, per trip or per vehicle per km or tkm), other emissions (CO, NO$_X$)

- **Mobility**
  - total/individual travel times, delays, number of stops, network speed, level of service

- **Safety**
  - times to collision, time headways, variations in speed, # hard braking events, speeding, distraction and workload

- **Compliance**
  - following advices: on vehicle condition and on strategically, tactically and operational driving

- **Driver performance**
  - gear changes, acceleration & deceleration performance, speed, idling

- **User acceptance**
  - system on/off, usefulness, ease of use, satisfaction with the system
Field trials

- Testing of applications for cars, trucks and traffic management in real world conditions
- Taking actual emission measurements & connect them to application usage
- Collecting objective & subjective feedback from drivers

<table>
<thead>
<tr>
<th>Test site</th>
<th>Vehicles</th>
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<tbody>
<tr>
<td>Munich (GER)</td>
<td><img src="image1" alt="Vehicles" /></td>
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<tr>
<td>Helmond (NED)</td>
<td><img src="image2" alt="Vehicles" /></td>
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<tr>
<td>Turin (ITA)</td>
<td><img src="image3" alt="Vehicles" /></td>
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</table>

Environment    | Mobility | Safety | Compliance | Driver performance | User acceptance | eCoMove | DLR |
|----------------|----------|--------|------------|--------------------|-----------------|---------|-----|

ITS World Congress 2011 (Orlando) / SS17 / Stefan Trommer (DLR)
Driving simulator studies

- Implementing and testing eCoMove applications in a controlled environment
- Three studies planned to cover different research questions (DLR, TUM, VOLVO)
- Testing different feedback and training strategies to improve driver performance:
  - Gear changes, acceleration & deceleration, compliance rate, HMI design, distraction

Environment - Mobility - Safety - Compliance - Driver performance - User acceptance
Traffic network simulation

- VISSIM environments of Munich, Helmond and French motorways
- eCoMove traffic management apps run in real-time mode
- Changes in driver performance are modelled based on findings from field trials and driving simulator studies
- Assessing direct and indirect effects:
  - total/individual travel times, delays, number of stops, network speed, level of service,
  - fuel consumption, CO₂ emissions (in total, per trip or per vehicle per km or tkm), other emissions (CO, NOₓ)
Sensitivity analysis

<table>
<thead>
<tr>
<th></th>
<th>Munich</th>
<th>Helmond</th>
<th>French motorways</th>
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<tbody>
<tr>
<td><strong>Type of signal control</strong></td>
<td></td>
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<tr>
<td>What are the gains of eCoMove in a less optimised environment?</td>
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<td>X</td>
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<td><strong>Fleet composition</strong></td>
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<td>What is the impact on fleets with less average emissions? Which effect has a higher or lower share of truck traffic?</td>
<td>X</td>
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<td>X</td>
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<tr>
<td><strong>System penetration</strong></td>
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<tr>
<td>It is important to demonstrate gains with lower penetration to encourage fast deployment</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td><strong>Incidents affecting the traffic network</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Incidents in the traffic network are regular and need to be analysed.</td>
<td>X</td>
<td>X</td>
<td>X</td>
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Next steps & outlook

• Definition of the data collection system
• Planning of scenarios for field trials & driving simulator studies
• Field trials start July 2012
• Assessment results expected December 2012
Thank you for your attention

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