Enabling automation for Heavy Duty Vehicles - What the key aspects are

Virtual, 9-10 September 2020

Dr. Marc-Michael Meinecke, Mikael Johansson
Volkswagen AG, SCANIA CV AB
PROBLEM DESCRIPTION

WHAT MAKES AUTOMATION OF HEAVY DUTY VEHICLES SPECIAL compared to cars?
WHAT MAKES AUTOMATION OF HEAVY DUTY VEHICLES SO SPECIAL?

• Transporting goods

• Professional drivers

• Commercial activity

• Vehicles are much bigger and heavier than cars. Sometimes they pull a trailer.
  → More difficult to manoeuvre.
EXEMPLARY DISTRIBUTION OF TRANSPORT COSTS FOR LONG HAULAGE TRANSPORT IN EUROPE

- Labour costs for truck driver sum up to 25 % ... 30% of total transport expenses
CURRENT SITUATION IN EUROPEAN LOGISTICS BUSINESS

• Demand on transports is growing
• Enormous international competition
• Truck driver shortage
CRUISE CONTROL
### EVOLUTION IN LONGITUDINAL ASSISTANCE

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Cruise Control</th>
<th>Adaptive Cruise Control</th>
<th>Adaptive Cruise Control – Active Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keep set speed</td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keep distance to vehicle ahead</td>
<td></td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>Incorporate vertical road layout</td>
<td></td>
<td></td>
<td>✔️</td>
</tr>
<tr>
<td>Main design criterion</td>
<td>Keeping speed limits</td>
<td>Keep safety distance to vehicle ahead</td>
<td>Reduction of fuel consumption</td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td>• Radar sensor</td>
<td>• Radar sensor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Map</td>
<td>• Map with vertical road layout info</td>
</tr>
<tr>
<td>HMI</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ADAPTIVE CRUISE CONTROL – ACTIVE PREDICTION

- Adaptive Cruise Control – Active Prediction bases on ACC
- Goal: Predictive adaptation of speed to minimize fuel consumption taking into account vertical shape of road
- Result: Reduction of fuel consumption up to 5% (highly depending on geometry)

Source: SCANIA CV AB
PLATOONING
PLATOONING – FUNDAMENTAL CONCEPT

- Air drag force of single (isolated) vehicle: \( F_L = \frac{1}{2} c_W A \rho v^2 \)
- Platooning idea:
  Driving in air shadow reduces air drag, reduces fuel consumption

\[
F_L = \frac{1}{2} c_W A \rho v^2
\]

Source: Assad Alam, KTH Stockholm

Source: SCANIA CV AB
PLATOONING – TECHNOLOGY

Distance keeping between vehicle n and (n+1) by:

- Communication of vehicle state via V2V (e. g. WLAN IEEE 802.11p)
- Additionally on-board-radar (for redundancy reasons)

The V2V technology enables to communicate changes in vehicle dynamic to other participants without any latency. That enables immediate adaptations of speed of all vehicles in entire platoon (“longitudinal stability of a platoon”).
PLATOONING — CHALLENGES

- Platoons consisting of many vehicles increase savings
- Platoons consisting of many vehicles might be recognized as a traffic blockage
- Required changes of legislation still under discussion
PLATOONING – EXAMPLES
# PLATOONING – PRO’S AND CONT’S

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Pro’s</th>
<th>Cont’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced fuel consumption</td>
<td>Possible due to lowered air drag</td>
<td>• Difficult to keep short distance due to other interfering traffic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Tolerances in mass estimation, brake performance make it difficult to maintain required time gap.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In an optimized platoon still differences in savings for the individual platoon members remain.</td>
</tr>
<tr>
<td>Driverless automated following a leading vehicle</td>
<td>Possible in case time gap is very close</td>
<td>• Platoon might be separated (e.g. due to intrusion of other vehicles). In this case each vehicle has to be able operate without leading vehicle anyhow.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Automation of independent vehicles might be possible. So, no leading vehicle is necessary at all.</td>
</tr>
</tbody>
</table>

Source: [https://www.youtube.com/watch?v=lpuwG4A56r0](https://www.youtube.com/watch?v=lpuwG4A56r0)
ALTERNATIVE TRANSPORT SOLUTIONS
BESIDE PLATOONING
ALTERNATIVE TRANSPORT SOLUTIONS BESIDE PLATOONING TECHNOLOGY

- Mechanically connected configurations with higher transport capacity
- Advantages:
  - Only 1 driver per truck-trailer-configuration needed
  - Less space occupied on roads
  - Less motor vehicles required
  - Less fuel consumption
  - Higher transport capacity in volume and weight
ALTERNATIVE TRANSPORT SOLUTIONS BESIDE PLATOONING TECHNOLOGY

- Mechanically connected configurations with higher transport capacity
- Advantages:
  - Only 1 driver per truck-trailer-configuration needed
  - Less space occupied on roads
  - Less motor vehicles required
  - Less fuel consumption
  - Higher transport capacity in volume and weight
AUTOMATION FOR HEAVY DUTY VEHICLES

EXAMPLES
EXAMPLE AUTOMATED DRIVING OF MOVING STREETWORK

- **AFAS**: Automated driverless securing vehicle for moving street work on highways
- Autonomous following vehicle to service vehicle (e.g. street-cleaner, lawn-mower, etc.)
- Accompanying vehicle is highly endangered to be hit by other traffic because of their high speed difference.
- Accompanying vehicle keeps distance to vehicle ahead by radar measurements. Lateral control is mainly bases on perception by camera and radar.

Innovation Award IAA Nutzfahrzeuge 2018
EXAMPLE OF AUTOMATED OFF-ROAD TRUCK

• Automation of a truck in off-road environment
• Sensors detecting surroundings, obstacles are represented in a grid map
• Path planner algorithm guides vehicle
EXAMPLE OF AUTOMATED MINING TRUCK

- Automation of tipper truck in Dampier salt mine in Rio Tinto/ Australia (in real customer operation)
- Automated truck follows a salt harvester machine and is being loaded. Afterwards the loaded truck drives automatically to an unload station.
EXAMPLE OF AUTOMATED MINING TRUCK

- Automated trucks do not need any space for a cabin any more.
- Former space for cabin can be used to increase loading volume.

Source: SCANIA CV AB Volkswagen AG | Konzernforschung | K-GERFA/F
CONCLUSIONS
CONCLUSIONS – WHAT THE KEY ASPECTS ARE

• For commercial goods transportation only driverless makes sense.
  • Comfort and convenience of the driver/passerenger is always an issue for passenger cars but not for transports of goods. So, any driver assistance or L3 functions targeting these topics are not relevant for trucks.
  • Automation for fuel savings is already achieved with ADAS functions. So, this is also not a driver for autonomous vehicles.

• Commercial vehicles have a business case, they can afford expensive technical equipment and still save money by removing the driver.
For passenger cars it is either a luxury function or a new mobility business model is required (like shared mobility and robo taxi).

• It’s easier to identify a limited ODD for a commercial vehicle since many transports by nature is very repetitive. Most commercial transports use the same main roads, e.g. through Europe.

• Technology-wise there are many similarities between heavy vehicle automation and passenger car automation.

• Future research activities will focus on increasing the performance of the perception system.
THANK YOU VERY MUCH FOR YOUR ATTENTION
ΕΥΧΑΡΙΣΤΩ ΓΙΑ ΤΗΝ ΠΡΟΣΟΧΗ
ENABLING AUTOMATION FOR HEAVY DUTY VEHICLES
WHAT THE KEY ASPECTS ARE

SEPTEMBER 9-10, 2020 • L3PILOT SUMMER SCHOOL • ATHENS/ GREECE
DR. MARC-MICHAEL MEINECKE (VOLKSWAGEN), MIKAEL JOHANSSON (SCANIA)
“NEW” ALLOWED COMBINATIONS IN GERMANY

- Combinations depicted are additionally allowed in Germany since 2017
- Limited to 40 tons weight
- Additional constraints have to be kept into consideration (for driver and route)

Source: SCANIA CV AB

New since 2017

Longer Truck 25,25 m @ 60 tons on Swedish Highway

Source: Schmitz Cargobull, Altenberge
# PLATOONING – PRO’S AND CONT’S

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Pro’s</th>
<th>Cont’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced fuel consumption</td>
<td>Possible due to lowered air drag</td>
<td>• Difficult to keep short distance due to other interfering traffic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Tolerances in mass estimation, brake performance make it difficult to maintain required time gap.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In an optimized platoon still differences in savings for the individual platoon members remain.</td>
</tr>
<tr>
<td>Driverless automated following a leading vehicle</td>
<td>Possible in case time gap is very close</td>
<td>• Platoon might be separated (e.g. due to intrusion of other vehicles).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In this case each vehicle has to be able operate without leading vehicle anyhow.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Automation of independent vehicles might be possible.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>So, no leading vehicle is necessary at all.</td>
</tr>
</tbody>
</table>

Source: [https://www.youtube.com/watch?v=lpuwG4A56r0](https://www.youtube.com/watch?v=lpuwG4A56r0)
CONCLUSIONS – WHAT THE KEY ASPECTS ARE

• For commercial goods transportation only driverless makes sense.
  - Comfort and convenience of the driver/ passenger is always an issue for passenger cars but not for goods transport so any driver assistance or L3 functions targeting these topics are not relevant for trucks.
  - Automation for fuel savings is already achieved with ADAS functions so this is not a driver for autonomous.

• Commercial vehicles have a business case, they can afford expensive sensors and so and still save money by removing the driver. For passenger cars it is either a luxury function or a new mobility business model is required (shared mobility and robo taxi).

• It’s easier to identify a limited ODD for a commercial vehicle since many transports by nature is very repetitive. Most commercial transports use the same main roads, e. g. through Europe.

• Technology-wise there is not a huge difference between heavy vehicle automation and passenger car automation.