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EUROPEAN TRUCK PLATOONING

European Truck Platooning Challenge 2016

Creating next generation mobility

Lessons Learnt

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European Truck Platooning Challenge 2016

Hypothesis and recommendations for future cross border Field Operational Tests of truck platooning in Europe

creating

next generation mobility

EUROPEAN TRUCK PLATOONING

EU 2016

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LEARNING AND SHOWING BY DOING

"The European Truck Platooning Challenge is the first successful experiment with cross-border platooning. Five member states and six European truck manufacturers participated in the unique Challenge, owing its success to constructive teamwork between public and private sectors. Players included road and vehicle authorities, logistics services companies, knowledge institutes and stakeholder bodies.

This initiative is a textbook illustration of the 'learning by doing' approach promoted by the Dutch presidency. I am absolutely convinced that lessons learnt from the Challenge, in terms of road and vehicle safety, fuel efficiency, as well as environmental and social aspects, will accelerate deployment of truck platooning. Meanwhile, it will also fuel current thinking around connected, cooperative and automated driving. This will support our efforts towards a general roll-out of Intelligent Transport Systems (ITS), giving us smarter roads and allowing for value added services to emerge.

Over the next several months we will prioritise smarter, cleaner roads and the removal of access barriers hampering the road transport market. This period will also see us preparing several initiatives for adoption in early 2017.

I am glad to present this booklet, packed with lessons learnt from the Challenge. It comprises analyses, conclusions and recommendations. Which excellently fits into the 'see-feel-change' approach in which we operate in order to respond to disruptive developments – like smart mobility. These will be building blocks for further field operational tests for truck platooning in Europe. Taking this approach, we will be working together towards real-life truck platooning corridors in Europe.

So pick these very valuable fruits and add your advantage!"

Violeta Bulc
EU Commissioner for Transport

The aim of the Challenge was to bring platooning one step closer to implementation. (From left to right:) Marc Billiet (IRU), Paul Schockmel (CLEPA), Godfried Smit (ESC), Erik Jonnaert (ACEA) and Steve Phillips (CEDR) signed a declaration of joint commitment to truck platooning. Not in this picture: Servi Beckers (EReg).

INTRODUCTION

The Netherlands launched the European Truck Platooning Challenge during its 2016 presidency of the Council of the European Union in 2016. Six brands - DAF Trucks, Daimler Trucks, Iveco, MAN Truck & Bus, Scania and Volvo Group – drove semi-automated trucks in platoons, on public roads from several European cities to the Netherlands. The aim was to bring platooning one step closer to implementation.

The Challenge took place on Wednesday 6 April 2016, with platoons of trucks arriving in Rotterdam from Sweden, Denmark, Germany, Belgium and the Netherlands. A unique aspect was the joint effort between authorities – European member states, road and vehicle approval authorities – and industry, working as equals, each on the basis of its own role and responsibility. Backing came from leading EU umbrella bodies including CEDR (road authorities), EREG (European vehicle and driver registration authorities), ACEA (vehicle manufacturers), CLEPA (automotive suppliers), IRU (hauliers) and ESC (shippers).

This practical test enabled all partners involved to move towards getting rid of existing borders between countries – in terms of legislation and regulation – and between the public and private sectors. For the first time Europe now had the necessary conditions in place for cross border, large-scale testing on open roads. This Challenge was to be a crucial further step towards innovative mobility in Europe.

Although not a research project as such, the EU Truck Platooning Challenge did provide a unique opportunity to gain experience and accumulate knowledge around cross border truck platooning on public roads, with mixed traffic. With an eye to moving forward, ACEA (yellow pages) and the authorities use this booklet to review what the Challenge has realised to date. The review takes in several sources as building blocks for future European truck platooning corridors and initiatives. These building blocks are featured in the last chapter: From Challenge to real life cases.

The actual exemptions are packed with information. This is especially so when combined with considerations used in constructing them. Chapter 2 shows this in terms of the impact on infrastructure and traffic flow and safety. Chapter 1 clarifies the differences in exemption procedures between the countries involved. Alongside the exemptions, the drivers of the platooning trucks were interviewed on their perspectives. Although subjective by nature, these make a valuable contribution, being based on hands-on ex perience of the Challenge; the results are shown in Chapter 3. Aerial footage shot from a light aircraft was used to get a better view of the interaction between truck platoons and other traffic. Chapter 4 shows the noteworthy observations from the air. Last but not least, Chapter 5 covers the results of the stakeholder consultation with almost 80 participants from the European Truck Platooning Challenge website community.

As well as comprising an analysis of the above sources this booklet acts as an information source, complementing the storybook on the Challenge. It is not designed to be a scientific report with final conclusions, but as a reinforcement to future truck platooning projects, initiatives and corridors.

We, as responsible umbrella organisations, will make every effort to operationalise truck platooning in the spirit of the Challenge and are very pleased with the role of ERTICO, home of Intelligent Transport Systems (ITS) in Europe, to continue the coordinated work of the Dutch presidency as of 1 July 2016.

ACEA
Erik Jonnaert

CEDR
Steve Phillips

CLEPA
Paul Schockmel

ESC
Godfried Smit

EReg
Servi Beckers

IRU
Michael Nielsen/Marc Billiet


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ANALYSIS OF THE NATIONAL EXEMPTION PROCEDURES

The main issue in the exemption process has always been getting partially automated trucks to drive safely on Europe's roads and across its borders. European legislation already stipulates that vehicles complying with requirements may be freely registered in any member state. However, this Challenge covers modified vehicles whereby special technology controls the distance between them. A distance which is much closer than the legal following distance.

To this end national authorities were required to approve modifications on the trucks and the following distances. The participating vehicles were type approved. The testing and approval only covered the new technology. The extra function concerned automatic braking and acceleration with V2V communication, also called 'cooperative ACC, C-ACC'. Each country conducted the approval in its own way. This lead to different outcomes in following distance and additional safety measures, like warning lights.

Reviewing the approval process we highlighted the institutes and procedures involved. For each country we listed:

1. Vehicle authorities:
which is/are the national institute(s) to which vehicle modification should be reported?

2. Application policy and procedure (if applicable):
what information should be provided and how?

3. Vehicle assessment and testing:
how do the authorities assess vehicle functioning?

4. The permit:
how is the applicant informed of the authority's decision?

5. Any other business.

The following chapter is based mainly on experiences of the EU Truck Platooning Challenge project teams. To better evaluate the exemption process, however, an official dialog with the mentioned authorities would be necessary in order to give more background and content. Given the restraint of time, this was not possible.

Sweden

1.Vehicle authorities
In Sweden the authorities were represented by:
- Trafikverket (national road authority), www.trafikverket.se
- Transportstyrelsen (road traffic authority), www.transportstyrelsden.se

2. Application policy and procedure
In Sweden the authorities put trust in the knowledge and reputation of the truck manufacturers. The authorities do not want to pretend that they have the knowledge to access the prototype of the vehicle. If they would do that, they would also bear responsibility. Truck manufacturers can apply for a prototype license plate. With this plate they can drive on Swedish public roads.

3. Vehicle assessment and testing
(not applicable)

4. The permit
Sweden issued a permit with a following time of 0.5 seconds at the maximum a speed in Sweden of 80-90 kph. High capacity vehicles (32 metre vehicle combinations) could be used on certain stretches of roads while platooning.

5. Any other business
The prototype approval procedure can be related to the geographical and traffic situation in Sweden. Truck manufacturers from Sweden had limited experience with vehicle authorities that want to do a vehicle assessement assessment for proto type vehicles. As mentioned earlier OEM's can test drive with a proto type licence plate. As a consequence, the OEM's carry more responsibility, as the authority does not give its opinion. These procedures might have been a reason why German and the Dutch approval authorities had more questions.

Denmark

1.Vehicle authorities
The Danish authorities were represented by:
- Vejdirektoratet (national road authority), www.vejdirektoratet.dk

2. Application policy and procedure
The Danish authorities work on the basis of mutual recognition. As the European Truck Platooning Challenge was the first practical example of truck platooning, Denmark's approach was to treat it a a once-off demonstration. Volvo Trucks and Scania made specific applications for the demonstration platoon to drive through Denmark. These applications were similar to those submitted to the Swedish authorities. In the context of the demonstration project Denmark was fully confident in the know-how from, and test reporting on the C-ITS braking system by the truck manufacturers. As the authorities did not conduct their own tests on the braking system the truck manufacturers had full responsibility. As noted, the European Truck Platooning Challenge 2016 was treated as a stand-alone demonstration project. For long-term testing exemptions the approach would probably be more similar to that in Germany, Belgium and the Netherlands.

The project and exemption process were coordinated by a dedicated task force, comprising several national authorities

3. Vehicle assessment and testing
(not applicable)

4. The permit
Denmark issued a permit for the specific platooning trucks for the specific date and route. The only exemption granted was permission to drive with a following time of 0.5 seconds.

5. Any other business
No further exemptions were granted and compliance was required with all other highway code regulations. This also applied to Denmark's specific "merging rule" for entering and exiting traffic on the highway.

Southern Germany (Bavaria and Baden-Württemberg)

1.Vehicle authorities
In Southern-Germany the authorities were represented by:

- Baden-Württemberg (B-W), (Traffic Ministry), www.mvi.baden-wuerttemberg.de
- Bavaria (Interior Ministry, including traffic), www.stmi.bayern.de

In the case of truck platooning the truck manufacturers based in Germany needed to ask permission in the federal state where they were based, e.g. Baden-Württemberg (B-W) and Bavaria. In many cases truck manufacturer can drive their prototypes on public roads, but in the Challenge following distance was also contested. Hence, approval was required from the authorities.

2. Application policy and procedure
Germany requires that a vehicle authority assesses the prototypes. In this case TÜV Süd and TÜV Rheinland. The TÜV engineers declare the vehicle fit to drive on German roads. The federal state, which is the departure point for the platoons must inform all its fellow states situated between there and the Dutch border. The rules of the assessment are determined by a technical service (TS) like TÜV or DEKRA. The truck manufacturer can choose its own TS. The rules are strict.

3. Vehicle assessment and testing
The Daimler vehicles were assessed by TÜV Rheinland and MAN went to TÜV Süd. The approach at TÜV Rheinland is similar to that in the Netherlands, including EMC and situations like platoon formation, normal platoon driving, car getting between the platoon, shifting a truck from front to rear and breaking-up the platoon. TÜV Süd operated a different policy on EMC.

4. The permit
Baden-Württemberg issued a permit with a following time of 0.5 sec at a maximum speed of 80 kph in the federal state. Bavaria's permit did not state a following distance. The OEMs selected a following distance that they deemed safe, being no closer than 0.5 sec.

5. Any other business
Contacts between the truck manufacturers and the German authorities were very professional. Applications were made on time and the application progress was monitored by the OEMs. Some additional requirements including a flashing light were shown to be quite effective. Other road users were well-informed about the Challenge and about why trucks were 'connected-up'. The RDW and Baden-Württemberg liaised regularly on progress. Bavaria and Baden-Württemberg also exchanged views. We gather that many stakeholders, like the unions and the rail industry were also involved in the meetings, while the 'Bundesministerium für Verkehr und digitale Infrastruktur'(BMVI) monitored the progress.

North Germany (Schleswig-Holstein)

1.Vehicle authorities
The Schleswig-Holstein authorities were represented by:
- Schleswig-Holstein (national authorities), www.schleswig-holstein.de

A foreign truck manufacturer seeking to enter Germany with a prototype, must apply in the federal state where it crosses the border - in this case the authorities in Schleswig-Holstein, which informs all federal states between the border and the destination; in this case Niedersachsen, Nordrhein-Westfalen and the cities of Hamburg and Bremen, which have special status in Germany.

2. Application policy and procedure
Germany requires that the prototype is assessed by a vehicle authority, often a technical service like the TÜVs or DEKRA. Their engineers give the OK for the vehicle to drive on German roads. The federal state then informs its fellow states and asks if there are additional requirements. So, irrespective of what the truck manufacturers do, Germany requires an assessment, the rules of which are set by the technical services (TS), such as TÜV or DEKRA. The truck manufacturer can choose its own TS. The rules are stringent.

3. Vehicle assessment and testing
Scania's vehicles were assessed by TÜV Rheinland; Volvo Group by TÜV Hessen in conjunction with RDW (Netherlands).

4. The permit
Germany issued a permit with a following time of 1.0 second at 80 kph.

5. Any other business
The applications for the OEMs were substantially behind schedule in Germany and the permits were only issued a day before the platoons entered the country. This was partially facilitated by the central Ministry for Transport and Digital Communication. The authorities mentioned that a next application for a longer time frame would require a more thorough technical examination of the vehicles.

Belgium

1.Vehicle authorities
The Belgian authorities were represented by:
FOD Mobiliteit en Vervoer, (central government), www.mobilit.fgov.be

2. Application policy and procedure
In Belgium the approval of prototype vehicles is the responsibility of the federal Belgium authorities (FOD). The states of Belgium like Brussels, Flanders and Wallonia are responsible for the exemption. This can include restriction on intersections. National legislation is created by the central government, FOD Mobiliteit en Vervoer. The Flemish Agency for Roads and Traffic was involved as the truck platoons crossed this territory.

3. Vehicle assessment and testing
The Netherlands (RDW) and Belgium cooperated in the assessment of prototypes which have not been approved by other EU member states.

4. The permit
The Belgian permit was based on the same assessment as in the Netherlands. The set following time was 1.0 - 1.2 sec with the maximum speed in Belgium at 90 kph.

5. Any other business
Other requirements were driving logs, driver names, copies of driving licenses and vehicle insurance information.

Other requirements Germany:
Other requirements for the EU TPC to comply within Germany were for instance:
- On 2-lane direction motorways, only 2 combinations are permitted in platoon;
- On 3-lane direction motorways all 3 vehicles are permitted in platoon (not all Bundesländer);
- The participating vehicles must be equipped with all safety systems represented in the application (ACC and AEBS warning functions). Before each journey, these must be checked for their functioning;
- Safety lights and special marking were required.

The Netherlands

1.Vehicle authorities
The Dutch authorities were represented by:
- RDW, (Netherlands Vehicle Authority), www.rdw.nl

As in Germany, truck manufacturers with a prototype must apply to drive on public roads.

2. Application policy and procedure
The ITS admittance procedure involves the gradual accrual of confidence, repetitively and step by step, based on wide-ranging risk analysis. Prior to sanctioning practical road testing, the RDW methodically checks all applications around new technologies and functionalities:
1. intake
2. desk research
3. testing at a closed site
4. admittance

3. Vehicle assessment and testing
RDW assessed all vehicles entering the Netherlands. During the assessment inspectors verified that the declared performances of the vehicles were matching the standards.

For instance on the declared versus measured maximum automatic de-acceleration on a closed proved ground. On approval by the OEMs, the RDW reused the technical information from vehicle assessments to this end. The actual information came from TÜV Rheinland and TÜV Süd. The basis for determining the following distance included these criteria:

a. Redundancy: is there a system that engages automatically and provides a safe new situation when the C-ACC no longer functions? Such systems can be supported by various radars, cameras and LIDAR. A given system is fully redundant if it takes over the entire braking process from the driver. It is semi-redundant where the driver needs to assist the brake in realising the full emergency delay;

b. Live video and audio connections between the trucks are additional measures to improve control;

c. Reliable signals:
this area is covered by EMC (electromagnetic compatibility). A vehicle with poor immunity and/or heavy emissions of EM radiation is vulnerable to interference of data signals around the control, which will reduce system reliability. RDW required EMC with this in mind.

4. The permit
The Dutch issued permits with following times ranging from 0.7 sec to 1.3 secs at 80 kph. All vehicles were admitted. The redundancy and reliability of systems were processed in the prescribed following distance in line with the criteria (3) above.

5. Any other business
The Dutch 'learning by doing and showing' approach raised many questions from the truck manufacturers. Some OEMs were unused to working with prototype assessments or strict procedures and rules. RDW's approach caused some disquiet, as the criteria were not clear from the outset, and delays resulted.

Despite frequent reminders applications arrived late at the RDW. And indeed, applications and documentation were often received piecemeal. Manufacturers stressed the importance of the non-disclosure undertaking. There were frequent route changes.

All in all, this increased the workload.
For some truck manufacturers submitting confidential information via the RDW website was a security issue. Although logging of vehicle data was required, RDW has yet to receive feedback.

CLOSING REMARKS

Vehicle authorities

- The Challenge clarified which national body/bodies are responsible for the approval of vehicle modifications as presented in the Challenge.
- Information on the Challenge is ongoing to this network and it can easily be reactivated for future projects.

Application policy and procedure (if applicable):

- What information needs to be provided when and how? There are differing national requirements for the approval of prototype vehicles like platooning trucks.
- The subsequent edition in cross border platooning should learn from this. Mutual recognition of rules can represent an initial step. In general, individual national requirements should be made clear well in advance.

Vehicle assessment and testing:

- How did the authorities assess the functioning of the vehicles? Most countries included the vehicle, the road and the interface between the trucks and other road users. Some countries actually established this procedure in national legislation (Netherlands) while others informed relevant bodies using a less formal procedure.
- Scandinavian countries do not carry out technical vehicle assessments. The Netherlands and Germany operate a strict EMC assessment. The underlying thinking is, that with an unreliable system (due to lack of EMC), the driver cannot respond effectively when driving at a short following distance.
- As EMC requirements were not totally clear to everyone, there was a lively debate. RDW must be clearer about this requirement in future.

The permit:

- In all countries the applicants were informed of the authority's decision and issued with a permit accordingly.
- The following distance was based on criteria, including those below:

  – Redundancy: is there a system that engages automatically and provides a safe new situation when the C-ACC no longer functions?
  – Reliable signals: this area is covered by EMC (electromagnetic compatibility). A vehicle with poor immunity and/or heavy emissions of EM radiation is vulnerable to interference of the data signals around the control. In most cases the permits contained information on following distance. The distance differed per country and, in one country , also per truck manufacturer.
  – ACEA set 0.5 sec as a minimum following distance. This and other boundary conditions were the same for all truck manufacturers. Some authorities considered 0.5 sec not a safe following distance due to the insufficient redundancy and reliability of the systems. OEMs tried hard to make the following distance as close as possible.

2

ANALYSIS OF EXEMPTIONS: TRAFFIC SAFETY CONSIDERATIONS

A total of nineteen exemptions were issued for the European Truck Platooning Challenge. OEMs had to obtain exemptions for every country driven through. Every federal state in Germany had to give its approval for truck platooning on its territory, although in some cases there was mutual approval of exemptions. One OEM drove through five countries and three German federal states, ending up with six exemptions.

Mitigating expected risks

Exemption applications are assessed in terms of vehicle and traffic safety. This chapter focuses on the impact on infrastructure and the traffic flow and safety.

In the exemptions, road authorities set out conditions under which they believe truck platooning can be safely operated on motorways in normal traffic. These rules and requirements have n-built expected risks and mitigation factors. Making these transparent is key to development of the truck platooning concept. Starting points can be shared and discussed. This evaluation report attempts to set out the point of departure for construction of cross border truck platooning corridors in Europe.

Content of the exemptions differs considerably from country to country and federal state. Some exemptions only take up two paragraphs while others need more than six pages. However, length is not necessarily conclusive and may demonstrate thoroughness, experience or the lack of it, or indeed, overregulation.

Structure of this chapter

Truck platoons differ from single trucks. These differences lead road authorities to expect calculated risks which they seek to mitigate with requirements and recommendations relating to the exemptions. The considerations reached by the authorities may not have been shared, but they can be deduced and this is the logic followed by this chapter. In the yellow and bleu cadres, examples can be found of requirements in exemptions regarding specific traffic situations or characteristics of the vehicle. It ends with an overview of the differing approaches by road authorities and how their liability impacts on the assessment approach.

Exemptions: road authorities

Road authorities assessed the applications for truck platooning in terms of the impact on infrastructure and traffic flow and safety.

Risks foreseen by road authorities

Seen from the angle of road management, the differences between a truck platoon and a regular single truck are determined by:

- Length
- Following distance
- Communication

Length

Trucks in a truck platoon are interconnected and can therefore be viewed as a single entity, the total length of which depends on the number of trucks and the following distance.

Tractor-trailer combinations were used in the European Truck Platooning Challenge. Under European guidelines for truck weight and dimensions, the maximum length of each combination is 16.50 m.

Expected risks:

- Greater likelihood of accidents/ disturbance within traffic flow due to the truck platoon acting as one single vehicle entity.
- Increased wear and tear to roads/ bridges due to the truck platoon operating as one vehicle entity.

Example of exemption requirements made for:

Layout of motorways and position of the truck platoon on the road

Schleswig-Holstein did not allow truck platooning on two-lane motorways, and Baden-Württemberg only allowed truck platooning on motorways with an emergency lane. Belgium confined truck platooning to the right lane, while the Dutch had a general ban on overtaking, which comes down to the same thing.

Following distance

The following distance between vehicles is regulated nationally. Some countries state this exactly in metres or minutes, while elsewhere regulators state 'a safe following distance'.

The European Truck Platooning Challenge maintained distances which were shorter than those legally required in the various countries.

Expected risks:

- Limitations of the platooning system in complex traffic situations.
- A truck driver unfamiliar with the platooning system not knowing how to deal with the transition of control.

Example of exemption requirements made for:

Visibility/recognition of the truck platoon

All German federal states involved required their truck manufacturers to place the message Vorsicht Testfahrt! Geringer Abstand on the side and rear end of the truck:

The federal states also required flashing lights as used in transportation of exceptional loads.

Example of exemption requirements made for:

Complex traffic situations

Different exemptions show that the following traffic situations are viewed as potentially risky: motorway junctions, traffic density, traffic jams, (mobile) roadworks and weather conditions. Motorway junctions and roadworks are clearly signed locations. A standard x kph can be used to indicate a traffic jam. But traffic density and weather conditions are not so easy to define.

One of the German federal states restricted truck platooning to dry, clear and favourable weather conditions.

Communication

The trucks communicate with each other. The lead truck intervenes in how the following truck(s) drive, in terms of acceleration, deceleration and braking.

Expected risk:

- Failure of the system in specific infrastructural situations: tunnels, slopes and curves.

Example of exemption requirements made for:

Tunnels

In the run-up to the European Truck Platooning Challenge there were a number of discussions around the robustness of the systems in tunnels. Initially truck manufacturers said they needed to know the exact location of tunnels and the length of the closed section. Eventually only One OEM said that this was useful information. The main conclusion of the discussions was that the tunnels on the route were too short to make system failures likely.

Belgium was the only country requiring truck platoons to decouple 200 metres before the start of the tunnel.

Expected risks of truck platooning	Mitigating expected risks
Increased chance of accidents/disturbance in traffic flow due to behaviour of the truck platoon as a single vehicle entity	Requirements for visibility/recognition of the truck platoon, decoupling at on and off ramps, restrictions/recommendations on specific manoeuvres, prescribed following distance, maximum speed
Increased wear and tear on roads/bridges due to the truck platoon as a single vehicle entity	Restrictions on maximum weight and division of load, decoupling at bridges
Limitations of the platooning system in complex traffic situations	Decoupling in complex traffic situations like motorway junctions, traffic density, traffic jams, (mobile) road works and weather conditions, set procedures for truck drivers, prescribed following distance
A truck driver unfamiliar with the platooning system not knowing how to deal with the transition of control	
Failure of the system in specific infrastructural situations: tunnels, slopes and curves	Decoupling at tunnels, x gradient values and x radius values of curves

Obviously we need to bear in mind that traffic conditions differ substantially between countries and locations. This applies to traffic density, share of different types of vehicles, road design in general, the lay-out of motorway junctions in particular, the number of motorway junctions, distances between motorway junctions, flat or hilly terrain, and the level of maintenance of the infrastructure. All this impacts on the way road authorities evaluate expected risks.

Mitigating risks by road authorities

Broadly speaking, we see three differing approaches within the European Truck Platooning Challenge:

- Self-reporting (Sweden and Denmark)
- Prescriptive (Germany and Belgium)
- Prescriptive and Code of Practice (the Netherlands)

The usual approach in exemptions is to prescribe the exact requirement or restriction. The two alternative approaches are clarified below.

Self-reporting

Sweden took the self-reporting approach, asking the truck manufacturers to identify the risks they expected and their plans for mitigation. The basic principle here was that the truck manufacturer bears full responsibility for anything that may happen en route, whereby it will do anything it can to prevent accidents occurring. It is in their best interest to treat possible risks seriously. Moreover, Sweden is quite reluctant to impose requirements, as this would suggest that a road authority is in a position to indicate the safest course of action (responsibility devolves on the road authority).

The Swedish government has launched a study into regulations for all kinds of tests into automated operations tests, i.e. all vehicle types. The relevant agencies are drafting requirements for reporting/describing tests by manufacturers before they can actually start testing their products on public roads. This will replace the 'self-report' approach.

Example of exemption requirements made for:

Maximum speed

All exemptions included the applicable rules for maximum truck speed for trucks. The maximum speed for trucks in Sweden, Denmark, Germany and the Netherlands is 80 kph, and in Belgium 90 kph. The required speed limiter for trucks has a tolerance up to 87 kph. The average actual driving speed of trucks is higher than 80 kph.

The German federal state of Baden-Württemberg differed, allowing a maximum speed of 85 kph, where the truck platoon had been broken up and the following trucks had to accelerate to re-form.

Denmark followed the Swedish approach, but treated the initiative as a one-off demonstration. The European Truck Platooning Challenge was their first experience in this area. For long-term tests the Danish approach would probably be more similar to Germany, Belgium and the Netherlands.

Code of Practice

As developed in the Netherlands the Code of Practice is a guide, issued to the driver by the road authority to evaluate the traffic situation. The Code of Practice is part of the Dutch 'learning by doing' theme at the country's ministry of Infrastructure and the Environment. Hence, every exemption and related Code of Practice is unique and may change in a subsequent situation. The Dutch philosophy says it is too early in the learning process for general rules governing all types of automated and connected vehicles, test conditions and purposes. One-fits-all rules would be too general and thereby obsolete in due course.

The Code of Practice forms an appendix to the exemption. Although the Code of Practice has no basis in law, in the event of an accident, proof of disregard of content could be a factor in court.

The Dutch Code of Practice sprang from a need to emphasise specific points without issuing them as requirements. One basic principle of the Code of Practice is that truck drivers are viewed as professionals, perfectly able to evaluate traffic situations by themselves. So, for example, the Netherlands did not require decoupling in situations like traffic jams or roadworks.

Like Denmark, the Netherlands distinguished between the character of the European Truck Platooning Challenge as a demonstration, and truck platooning as a test. Many of the rules in the Code of Practice did not relate to expected risks of the truck platoons as such, but rather to expected risks due to media activity or the behaviour of accompanying vehicles of the truck platoons.

The UK published a general Code of Practice for all types of tests with automated and connected vehicles. Belgium will follow this approach.

Liability of road authorities

On 7 March 2016 representatives of the national road authorities met in Brussels to prepare for the European Truck Platooning Challenge. The idea arose of setting a following distance per motorway junction, dependent on the distances between acceleration and deceleration lanes, the length of these lanes and the average traffic density. Some of the countries strongly argued

Maintaining and (re) forming the truck platoon

In the Code of Practice, the Netherlands inserted some recommendations regarding maintaining and (re) forming the truck platoon. These recommendations sprang from the experience of a former truck platooning demonstration in the Netherlands. Before going on the motorway, the three-truck platoon had to negotiate a roundabout, regulated by traffic lights, whereby one of the trucks was left behind. The truck drivers of the other two trucks decided to wait on the hard shoulder of the acceleration lane. Once the third truck approached, they moved from the hard shoulder into traffic on the acceleration lane.

As hard shoulders are not meant for (re)forming truck platoons the Dutch road authority aimed to stop it happening and made a rule to this effect in the Code of Practice. (Re)forming the truck platooning when entering the motorway is a typical focus point for the truck platooning concept that needs further exploration.

against differing following distances per location. The argument was that in the event of an accident it would appear that the truck platoon had complied with the following distance as set, and the road authority would be responsible.

There is a large grey area around the liability of road authorities. Road authorities have a duty of care for road users. Road users have the right to expect that the road is fit for purpose. The duty of care should cover all road users, even if these are autonomous cars. This field of knowledge is new territory. Although the legal experts assume that change will be minimal, case law should create greater clarity.

This would be the situation when smart vehicles adapt to the roads and there are no changes in the current state of the infrastructure. The situation could change if, for example, road authorities created new standards for road markings, in support of lane departure warning systems. The system settings will be designed for the new road markings standards. If the road markings do not match these standards, for example because of damage caused by an accident, the road authority could be responsible.

CLOSING REMARKS

As a result of the aforementioned analysis the following table has been derived. In the last chapter the expected risks are combined with the results of the analysis of the truck drivers interviews and the aerial footage.

Expected risks of truck platooning	Mitigating expected risks
Higher chance on accidents/disturbance of the traffic flow because of the behaviour of the truck platoon as one vehicle entity	Requirements on the recognisability of the truck platoon, decoupling at on- and off ramps, restrictions/advise on specific manoeuvres, prescribed following distance, maximum speed
Increased road/bridge wear and tear because of the truck platoon as one vehicle entity	Restrictions to the maximum weight of the load and the division of the load, decouple at bridges
Limitations of the platooning system in complex traffic situations	Decouple in complex traffic situations like motorway junctions, traffic density, traffic jams, (mobile) road works and weather conditions, requirements on the truck driver, prescribed following distance
A truck driver unfamiliar with the platooning system does not know how to deal with the transition of control	
Failure of the system in specific infrastructural situations: tunnels, slopes and curves	Decouple at tunnels, x gradient values and x radius values of curves

3

INTERVIEWS WITH THE TRUCK DRIVERS

The people behind the wheels of the six truck platoons was a mix of diiferent types of truck drivers. Some were ordinary truck drivers or system developers, and others were test drivers employed by the truck manufacturers. All were familiar with driver support systems and had experience with truck platooning.

Eighteen drivers of the truck platoons were interviewed on the morning of 6 April. Seven of these were in a lead truck and ten drove following trucks. In addition, one drove both a lead and a following truck and his answers were included with the answers of lead truck drivers.

The interviews were designed to boost the aerial recordings with observations from the truck drivers, the main purpose being to learn about the interaction of truck platoons with other road users, for example at entries and exits.

Questions in the interviews were approved in advance by the truck manufacturers. Relevant questions for the report were as follows:

1. With manoeuvres like overtaking, merging, weaving, accelerating, decelerating, braking: how did you drive differently in a truck platoon compared to a normal truck?
2. Did you notice any reactions from other road users (car and/or truck drivers) to the truck platoon which differed from the situation with normal trucks? If so, please describe some of these situations.
3. Did you need to decouple because of the traffic situation and what type of traffic situation was this?
4. Were there occasions where it was difficult to comply with traffic rules?
5. Were there situations where road design led to problems with other road users?
6. Are there any other noteworthy matters remaining?

Given the small number of truck drivers interviewed, the results are presented in statements made by these drivers.

Question 1:

With manoeuvres like overtaking, merging, weaving, accelerating, decelerating, braking: how did you drive differently in a truck platoon compared to a normal truck?

Most truck drivers said that the chief difference between driving a truck platoon and driving a single truck, was awareness of being part of a single entity and the entity's position in traffic.

In this context drivers mentioned:

- As a lead truck driver you need to be aware of the full length of the platoon;
- As a lead truck driver your main task is to keep the platoon together, e.g. with speed control;
- The lead truck driver mainly tends to look ahead, watching out for potential problems;
- When approaching on- and off-ramps, the lead truck driver should also take account of single trucks behind the truck platoon;
- Compared to driving a single truck, the lead truck driver maintains a greater distance from road users in front of the truck platoon;
- Driving a truck platoon requires a different way of anticipating events involving other road users, especially trucks;
- Radio communication is important in informing drivers of following trucks; video communication is for verification.
- Drivers need to cooperate in anticipating traffic situations, e.g. lane changing.
- When the first one leaves the platoon any other truck can become a lead truck.
- One driver stated that he found social benefits, as he could communicate with other drivers.

The platooning support systems functioned very well, also in complex traffic situations. Automatic manoeuvring went smoothly, as with opening-up the platoon for merging cars and speeding-up again to re-form the platoon. When the truck platoon is broken up, a speed limit tolerance of 80-85 kph will be needed to re-form.

According to the drivers, on- and off-ramps are the most challenging traffic situations, particularly when merging with single trucks. In contrast to the single truck situation, feeding in between two trucks of the platoon is seen as 'breaking into'.

"The platooning support systems functioned very well, also in complex traffic situations."

The trucks changed lane simultaneously (all went from lane A to B at the same time, rather than trailing). In this scenario the lead driver ensures there is sufficient room for both trucks before changing into the new lane. The driver of the last truck can keep an eye out for other road users.

For the driver the steepness of the road is more stressful than the shorter following distance.

Question 2:

Did you notice any reactions from other road users (car and/or truck drivers) to the truck platoon which differed from the situation with normal trucks? If so, please describe some of these situations.

Initially most truck drivers say that road users react no differently to the truck platoon. However, in the second instance they do cite differing behaviour around overtaking and merging.

"Truck platoons are more troublesome for other road users than the other way around."

Other road users were not aware that they were driving near a truck platoon.

Overtaking

Drivers made mixed remarks regarding overtaking manoeuvres by other road users. Some said that overtaking manoeuvres by trucks were rare.

They observed that road users (car and truck drivers) were more reluctant to overtake and took longer to decide on overtaking. Occasionally single truck drivers would abort the overtaking manoeuvre when they realised the full length of the platoon.

In contrast, other drivers observed more overtaking manoeuvres, especially by trucks. Some truck drivers were irritated on discovering how long it took to get by the full length of the platoon.

Speed is a determining factor in the number of overtaking manoeuvres. Where maximum speed is more in line with trucks' actual driving speeds, fewer trucks tend to overtake. A maximum speed of 80 kph disrupts traffic flow with trucks seeking to overtake, even if this is prohibited. A maximum speed of 80 kph prompts substantially more overtaking manoeuvres by other trucks than would be the case if the truck platoons were driving more in accordance with the actual driving speed of normal single trucks. Overtaking by trucks was less in Belgium, where the maximum speed is 90 kph.

Merging

People driving at a following distance under eighteen metres, do not merge as often as when the following distance is longer.

"It was really annoying when merging traffic cut into the platoon; every time this happened the platoon broke contact automatically and you had to reconnect again - this was time-consuming."

The flashing lights on the trucks worked quite well in communicating with other road users. People tended not to go between them.

Platooning with a following distance of 0.8 sec. seems to confuse drivers of single trucks. Apparently there is room to merge, but the truck platoon does not widen the gap. Platooning at 0.5 sec. it is clearer for drivers of single trucks, some of whom flashed their lights or gesticulated that they wanted to merge.

According to one driver the lead driver in a three-truck platoon is not always aware of a platoon break-up due to merging traffic between the second and the third truck. However, another driver said that the lead truck driver could indeed see from the following distance when the platoon was broken.

Question 3:

Did you need to decouple because of the traffic situation and what type of traffic situation was this?

In complex traffic situations drivers decoupled on their own initiative - even if not required.

Most truck drivers cited the following traffic situations where they decoupled:

- Motorway junctions and on- and off-ramps. One truck driver found this irritating. Another said that it could be dangerous in Germany due to lack of space for merging. Decoupling was mainly required at on-ramps with trucks seeking to merge.
- In dense traffic situations.

Fly-overs, (narrow lanes at) road works, heavy rain, diversions and urban areas were only mentioned once or twice:

One driver said that they only decoupled when the lead truck had to brake. In all other situations they made the system 'passive', meaning that the gap between the trucks in the platoon was automatically increased to 50 m.

The effectiveness of the truck platooning concept is reduced when there are a large number of on- and off-ramps close together. The fact that the following distance was 0.8 sec., meant a large number of decouplings

Question 4:
Were there occasions where it was difficult to comply with traffic rules?

Compliance was only difficult in the case of maximum speed. One driver stated that the following truck exceeded the 80 kph maximum speed when catching up with the lead truck, however, the maximum was always within the 'tolerance limit'. According to another driver the truck platoon sometimes slowed down to enable an overtaking manoeuvre by trucks driving behind the platoon.

"Due to speed limits, in some areas, they had to go very slowly (mostly in Germany, around 50 to 60 kph), then they had to speed up (sometimes 70 to 80 kph) as they considered the situation quite dangerous with other trucks accelerating to try and overtake the whole platoon. As well as being dangerous that also hinders adequate traffic flows."

Question 5:
Were there any situations where road design led to problems with other road users?

Only a few such situations were mentioned:
- Two drivers stated that in Germany some motorway on-ramps were way too short. This complicated the driving task somewhat. It was more problematic for the truck drivers to use these short entrances as, being a platoon, you take up more space. The longer an on-ramp the better.
- One driver stated that road markings need to be improved to support platooning.

Some drivers cited these challenging traffic situations:
- Changing lanes was problematic as was driving alongside roadworks, especially when lanes were narrower than normal.
- On- and off-ramps were challenging, and the same applied to weaving on motorways. At all times drivers needed to remember that they were part of a platoon

Question 6:
Are there any noteworthy matters remaining?

Visibility/recognition of the platoon
Putting stripes on the trucks would help identify them as a platoon. Recognition promotes meaningful communication between truck platoon drivers and colleague single truck drivers. A text is helpful, but visual effects are preferable. Drivers going through Germany found their flashing lights to be a useful means of communication with other road users.

Experienced drivers
Experienced truck drivers are important. They know the eventualities and can respond accordingly.

Communication
A screen in the cab showed the traffic situation in front of the leading truck. This was very helpful.

Truck platooning corridors
Certified routes for platooning can be a valuable asset.

Copycat behaviour
Frequent copycat behaviour was noted and viewed as dangerous. This occurred on German motorways. Copycat behaviour is when other single trucks copy the behaviour of the truck platoons, probably in this situation meaning driving more close to the front truck than normally.

Differences per country
Swedish traffic conditions are not so dense. In the Netherlands and Belgium single trucks normally drive with shorter following distances than in Sweden, and traffic in these countries is also more aggressive. The truck driver population is more diverse (more nationalities). Also, there are more and wider motorway lanes.

Platooning in the Netherlands was more comfortable because of the quality of the road surface.

CLOSING REMARKS

The truck drivers' observations back up the findings of other research methods. The absolute number of truck drivers interviewed within the European Truck Platooning Challenge was low, and this reflects accordingly on results. Subjectivity of data should be borne in mind when analysing observations by the truck drivers. Even so, they are at the 'sharp end' of the traffic scene and communicate mutually and directly as well as with other road users.

In the table below, the statements of the truck drivers are combined with the mitigating measures taken by authorities for expected risks.

Expected risks of truck platooning	Mitigating expected risks
Increased risk of accidents/disturbance of traffic flow due to the behaviour of the truck platoon as a single vehicle entity	Requirements on visibility/recognition for the truck platoon, decoupling at on- and off-ramps, restrictions/recommendations on specific manoeuvres, prescribed following distance, maximum speed
Interviews	The main difference between driving a truck platoon and a single truck, is being part of an entity. When evaluating traffic situations, the lead truck driver has to take account of the full length of the platoon. He has a sense of responsibility for drivers in the following trucks. Truck platoon drivers are strongly inclined to keep the platoon together. They regard merging traffic as breaching the integrity of the platoon and view on- and off-ramps as the most challenging traffic situation. Truck platoon drivers are not inclined to increase the following distance for overtaking single trucks, when this manoeuvre takes longer than the driver of the single truck expects. In the drivers' experience interaction of the truck platoon with single trucks is more complicated than with car drivers. Minor speed differences could be a reason here. Miscommunication is mainly due to the fact that the truck platoon is not recognisable as such. Some drivers would prefer a means of visibility/ recognition between the truck platoon and other road users. Maximum speed is a determining factor for the number of overtaking manoeuvres by single trucks. A maximum speed of 80 kph means that the truck platoon could hold up traffic flow. A speed limit tolerance 80-85 kph is needed to re-form the truck platoon when broken up.

Expected risks of truck platooning	Mitigating expected risks
Increased road/bridge wear and tear due to truck platoon as single vehicle entity	Restrictions on maximum weight and division of load, decoupling at bridges
Interviews	No information from the interviews
Limitations of the platooning system in complex traffic situations	Decoupling in complex traffic situations like motorway junctions, traffic density, traffic jams, (mobile) road works and weather conditions, set procedures for truck drivers, prescribed following distance
A truck driver unfamiliar with the platooning system not knowing how to deal with the transition of control	
Interviews	Drivers decoupled at complex traffic situations on their own initiative, even when not required. The main traffic situations where the truck platoons decoupled were at motorway junctions, on- and off-ramps and in dense traffic situations. The platooning support systems functioned very well, also in complex traffic situations. The driving task is getting easier in free flow traffic situations, but it is getting neither easier nor more difficult in complex traffic situations; different driver competences are required than for a single truck. The effectiveness of the truck platooning concept decreased apace with a large number of on- and off-ramps in close succession. A following distance of 0.5 sec. works better in keeping the truck platoon intact. A following distance of 0.8 sec. and above means more frequent merging in traffic and overtaking manoeuvres.
Failure of the system in specific infrastructural situations: tunnels, slopes and curves	Decoupling at tunnels, x gradient values and x radius values of curves
Interviews	The interviews yielded minimal information on these expected risks. One driver stated that the steepness of the road is more stressful than the shorter following distance. Another driver stated that they decoupled at fly-overs.

Feedback ACEA manufacturers

ACEA European Automobile Manufacturers Association

Feedback from ACEA truck manufacturers and next steps

European truck platooning challenge (ETPC)

ETPC FOLLOW-UP MEETING

GLASGOW – 6 JUNE 2016

dinsdag 14 juni 16

WHAT HAVE TRUCK MANUFACTURERS EXPERIENCED

- **A real challenge:** different exemption procedures, different legal requirements and different safety rules in member states made this a real "challenge".

- **One time is not enough:** further demonstrations are needed in order to gain more experience and knowledge in real traffic conditions.

- **Make it like in a platoon:** to strengthen and extend the cooperation with all the concerned stakeholders is key for driving forward.

WHAT OBSTACLES SHOULD BE ADDRESSED

- **Lack of knowledge:** more experience and knowledge about platooning in real traffic conditions need to be collected e.g. how many trucks to be allowed in a platoon, what are traffic and/or driver reactions to platoons, etc.
- **Harmonisation:** harmonized regulations and exemption processes are needed in order to allow for use of platoons.
- **Acceptance:** to make sure that there is enough political support to innovative vehicle concepts like platoons on European highways. What about public opinion? Drivers?
- **Market uptake:** platoons are neither a national nor a one-brand issue: customers need multi-brand solutions for international transport.

HOW TO DRIVE FORWARD

- **Development:** further availability of enabling technologies and standards as well as upgrade of the infrastructure to platooning requirements.
- **Identification and review** of existing legal and policy framework relevant for platooning.
- **Further joint research opportunities** and show-case activities needed e.g. cross-border and multi-brand platooning, high-scale demonstrations, etc.
- **Strengthened and extended cooperation** with all concerned stakeholders e.g. infrastructure, logistics, etc.
- **Clear political support and willingness** to further implement platooning on EU roads.
- **To support market uptake of truck platooning through incentives**, e.g. tolls/tax reduction, driver's social legislation, etc.
- **Governance for the follow-up of ETPC:** proper leadership and governance to ensure the success of future initiatives.

THE ROLE OF MANUFACTURERS

1. **Further develop enabling technologies and its applications,** including communication standard for multi-brand platooning
2. **Reflect on next steps** of large-scale implementation
3. **Share feedbacks** about platooning in real-traffic conditions
4. **Contribute with technical expertise to streamlining a positive framework,** allowing for cross-border truck platooning on a normal basis.
5. **Contribute with facts and figures** regarding advantages and risks of platooning on EU roads
6. **Perform large scale demonstrations,** with the support of EU institutions and other stakeholders

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1991
2016
ACEA


4
MAN
MAN Truck2Truck

ANALYSIS OF AERIAL FOOTAGE: LEARNING BY OBSERVING

In the spirit of the recently signed Declaration of Amsterdam[1] we aimed to learn as much as possible from the EU Truck Platooning Challenge, and to share these lessons. While the Challenge was not a research project as such, driving cross border on public roads in mixed traffic was a unique opportunity to gain knowledge about platooning in general and interaction with other traffic in particular.

[1] http://english.eu2016.nl/documents/publications/2016/04/14/declaration-of-amsterdam

Eye in the sky

Installing data loggers and cameras in or on trucks was not feasible and instead it was decided to have an eye in the sky. A light aircraft carrying a camera crew followed several of the platoons as they drove through the Netherlands on 1 and 5 April, before arriving in Rotterdam on 6 April. Reference material was also collected concerning unequipped trucks driving both in free flow and in groups similar to platoons.

An online GPS tool, produced by Simacan[2] and TomTom[3] and commissioned by the Innovation Lab[4], was used to track and trace the platoons. The aerial footage was gathered by Vigilance B.V.[5] and MAP traffic management[6]; the latter also provided an analysis of this material. In addition, the Technical University of Delft examined the aerial footage and provided feedback. The following observations were made on the basis of this material.

[2] https://www.simacan.com/en/2016/04/07/eu-truck-platooning-challenge-live-gps-monitoring/

[3] http://www.tomtom.com

[4] http://innovatiecentrale.nl/en/eu-truck-platooning-challenge-2016

Observations - general

Firstly, it should be noted that we only gathered a limited amount of aerial footage in the Netherlands, during the course of just two days of the overall Challenge. This means that the observations only relate to the situation in the Netherlands in the context of given conditions for those days, e.g. fair weather, free flow traffic during day time, no work zones, etc. Moreover, as we only had one aircraft and the platoons were driving simultaneously on differing routes we were unable to capture all six platoons involved. A further complication was that some people strayed from the itinerary.

Furthermore, over and above the limited aerial footage, it should be noted that

[5] http://www.vigilance.nl

[6] http://www.maptm.nl

Figuur 4.1 *Eye in the sky*

Figuur 4.2 *Screenshot of the Simacan / TomTom control tower. This screenshot was captured at an early stage where Scania and DAF Trucks were the only ones who had activated the GPS device.*

the EU Truck Platooning Challenge does not represent platooning in an operational setting as might be envisaged in deployment for day-to-day operations. The Challenge was a once-off event with highly qualified and motivated truck drivers and engineers who were quite familiar with the systems and their limitations.

Observations - specific

The main purpose of observing the platoons from the air was to obtain information on the way the platoons interacted with other traffic. Generally speaking, the focus was on two particular issues with potentially negative impacts on truck platooning. This involved the possibility – or not – of merging and overtaking by regular traffic where platoons were involved. Perceptions here are often fuelled by the idea that platoons are made up of a lot of trucks rather than just two or three, as with the Challenge; the point of reference being that traffic flow is only made up of ordinary cars rather than trucks. However, the images do not seem to show any such adverse effects.

Merging

There were no problems in merging traffic at on- and off-ramps, as most of the time the truck platoons gave way to traffic by creating larger gaps after deactivating (or decoupling) the systems, as set out in the Code of Practice. However, we did notice a situation, making us rethink whether this is invariably a good idea (see intermezzo). In fact, what we saw was that for most platooning trucks, with headways in the Netherlands ranging from 0.7 to 1.3 sec., gaps were larger than with non-equipped trucks. This is consistent with the findings of an

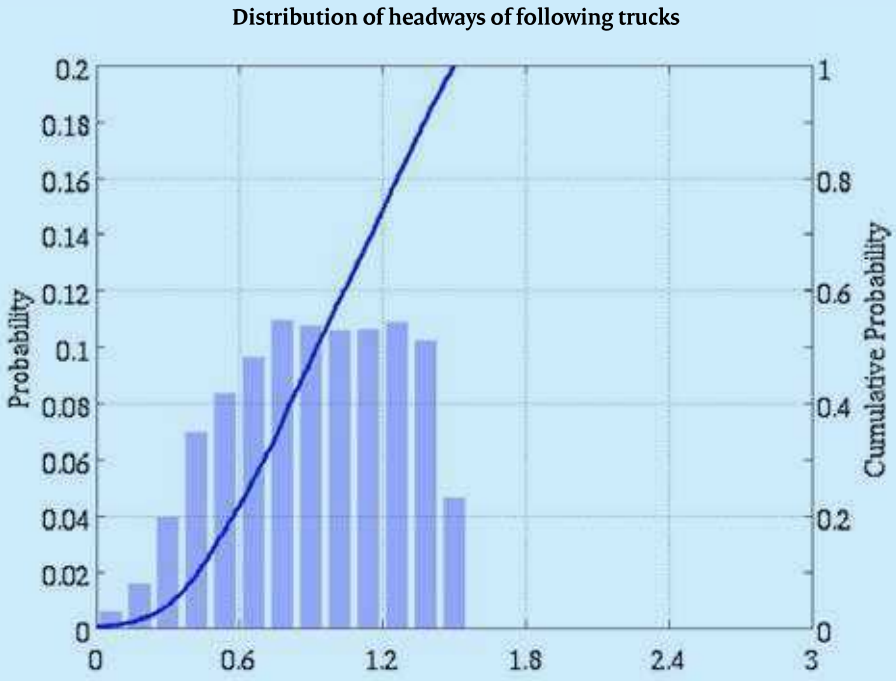

Figure 4.3 *Observed headways between trucks on the A15 in The Netherlands, ranging from 0.1 to 1.5 seconds*

earlier study where a large number of short headways were observed on the A15, see figure 4.3.

Gap acceptance

The temporarily decreased gap acceptance for merging traffic does not seem to be affected by the concept of platooning. This is because most traffic was unaware that the trucks encountered were platooning. They simply did or did not accept an available gap on the basis of the actual length and irrespective of truck mode.

Formation and regrouping

As a result of decoupling in the vicinity of on- or off-ramps, platoons have to regroup once they have passed by. This process takes some time, ranging from 30 to 60 seconds. The benefits of platooning will not materialise during this process. This is also the case when another vehicle "invades" the platoon and the following truck automatically increases its headway. Occasionally we actually saw trucks cutting in on multiple cars

(first one, followed by more), making it quite difficult for the platoon to regroup.

Overtaking

Queues of ordinary cars overtaking truck platoons on the adjacent lanes do not show much difference from overtaking unequipped trucks. The main cause here is the difference in velocity rather than the length of gaps between trucks. We also noted that in general cars are reluctant to drive between trucks, whether or not they are platooning.

Speed limit

We also noted quite a few non-equipped trucks overtaking the platoons, probably because the platooning trucks were strictly observing speed limits without any margin.

Another result of platoons keeping to the speed limit was that on several occasions we noted non-equipped trucks stuck behind the platoon.

Following distance

As we noted, the distance between the lead truck of a given platoon and the traffic in front was often larger than for normal trucks.

Figure 4.4

The two non-equipped trucks behind the 3-truck platoon clearly have shorter headways

Figure 4.5

Two cars driving between the second and third trucks.

Figure 4.6

Two cars driving between the second and third trucks.

Figure 4.7
Normal truck merging into the 2-truck platoon

Figure 4.8
Queue of cars overtaking non-equipped trucks.

Figure 4.9 *Two following trucks are giving way after the platoon decoupled.*

Lane changing

Apparently, for platoons to change lanes as a "team" is a relatively swift manoeuvre, often taking less than 10 seconds. When they decouple to change lanes individually it takes a bit longer, due to the presence of other traffic.

Courteous behaviour

Trucks in the Challenge conducted themselves in a courteous manner, including giving way to merging trucks and decoupling before on-ramps to create larger gaps to accommodate merging traffic. This conduct was partly due to some manoeuvres being included in the Code of Practice.

Figure 4.10
Two-truck platoon approaching on ramp.

Figure 4.11
Platoon decouples and creates a larger gap.

Figure 4.12
The merging truck accepts a 3 m headway.

Figure 4.13
The merging truck cuts in front of the overtaking truck.

Intermezzo

The Code of Practice stated that trucks should decouple when approaching on- and off-ramps, to permit other traffic to merge. Here (Figures 4.10-4.13) we see a two-truck platoon decouple and increase headway from approximately 15 m to 26 m which translates as 0.7 sec. and 1.2 sec. respectively, at a velocity of 80 kph. There is a merging truck on the on-ramp and an overtaking truck on the lane to the left of the two-truck platoon. We see the platoon decouple in figure 4.11, while the merging truck lines up with the gap created. In figure 4.12 the truck merges and accepts a very short 3 m headway (0.14 sec. at 80 kph). The truck continues to merge onto the lane to the left of the platoon, cutting in front of the overtaking truck, as can be seen in figure 4.13. In this situation it is fair to ask whether it would not be safer for the platoon not to decouple. The truck would have to merge behind the platoon, giving it a better view of traffic.

CLOSING REMARKS

The aerial footage provided very valuable information with respect to the interaction between truck platoons and the other traffic, especially in the neighborhood of on- and off ramps and during overtaking situations. For the other expected risks, nothing could be concluded.

Expected risks of truck platooning	Mitigating expected risks
Higher risk of accidents/disturbance of the traffic flow due to the truck platoon acting as a single vehicle entity	Requirements on the visibility/recognition of truck platoons, decoupling at on- and off-ramps, restrictions/recommendations on specific manoeuvres, prescribed following distance, maximum speed
Analysis aerial footage	No conclusions can be reached from aerial footage on visibility/recognition of truck platoons. This would require feedback from the drivers of non-equipped vehicles and/or a specific experimental setup with recognisable and unrecognisable truck platoons. It is not feasible to keep the platoon together at all times. Reasons for breaking up the platoon may be deliberate or unintended, and are mainly associated with merging and overtaking. **Deliberate decoupling** Platoons mainly decouple in the vicinity of on- and off-ramps so that other traffic can merge. In at least one situation (see intermezzo) this prompted a debate on whether it was actually necessary as the observed situation appeared unsafe compared to a platoon sticking together. **Unintended decoupling** When other traffic (cars or unequipped trucks) "invade" a platoon, the automated decoupling procedure which is initiated causes the leading trucks to "fall back". Remark: it is likely that the decoupling procedures observed near on- and off-ramps were initiated by the driver, whereas decoupling due to other traffic cutting into the platoon was automatic; however, this cannot be determined due to the absence of system status information. It has been observed that with these headways (> 1.0) other traffic (even trucks) is more inclined to merge in a platoon and initiate decoupling. Due to the fact that the truck platoons were driving slower than other trucks we noticed that the latter were either getting "stuck" behind platoons or would overtake them, if they had the opportunity. Overtaking platoons seemed to be more frequent than overtaking normal trucks.

Expected risks of truck platooning	Mitigating expected risks
Increased road/bridge wear and tear with truck platoon as single vehicle entity	Restrictions on maximum weight and division of load, decoupling at bridges
Analysis aerial footage	No conclusions can be reached from aerial footage here
Limitations of the platooning system in complex traffic situations	Decoupling in complex traffic situations like motorway junctions, traffic density, traffic jams, (mobile) road works and weather conditions, set procedures for truck drivers, prescribed following distance
A truck driver unfamiliar with the platooning system not knowing how to deal with the transition of control	
Analysis aerial footage	In the aerial footage no complex traffic situations involving traffic jams, road works, or adverse weather conditions were observed, hence no conclusions can be drawn regarding these situations.
Failure of the system in specific infrastructural situations: tunnels, slopes and curves	Decoupling at tunnels, x gradient values and x radius values of curves
Analysis aerial footage	Nothing can be concluded from aerial footage here

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STAKEHOLDER CONSULTATION

Challenges and open questions ahead of the Vision Truck Platooning 2025: results from the stakeholder consultation

Seventy-nine members of the EU Truck Platooning Challenge network took part in the online Stakeholder Consultation survey. This provided general answers around open challenges to truck platooning and forecast timelines for platooning's development. Key finding was that many parties agreed on the paramount importance of functional safety whereby this should drive deployment and acceptance of truck platooning in society at large.

The aim of the stakeholder consultation - to validate the Vision Truck Platooning 2025

The past months leading up to the European Truck Platooning Challenge, have seen a large number of meetings and workshops. Discussions covered challenges to making truck platooning a reality, with many areas covered including safety and security, technology development, legal issues, road infrastructure, and human behaviour. The Logistics Expert Meeting in February also covered the business case for transport companies and acceptance by drivers and other road users.

The Stakeholder Consultation had two goals in mind:

1. To validate and build wide-ranging support for Vision Truck Platooning 2025.
2. To identify as many challenges as possible, and open questions on the road towards commercial deployment of truck platooning.

The process of the stakeholder consultation - to hone known challenges and identify blind spots

The starting point here is TNO's 2015 white paper entitled "Truck Platooning: Driving The Future of Transportation" for a listing of barriers and challenges on the way to truck platooning. As well as working to corroborate the barriers set out in TNO's white paper, we also aimed to detect blind spots: challenges and open questions emerging over the past year that require special attention over the next several years.

Challenges and barriers - functional safety is paramount

The table below sets out key challenges and open questions listed by at least five respondents from the network. Self-evidently, many of the descriptions have been rephrased and edited to boost comprehension as far as possible. The respondents have also provided a large number of valuable suggestions – some most original – and we have included these under 'blind spots detected'.

SAFETY AND SECURITY	
Challenges and open questions	Demonstrate functional safety of platooning Cyber security, hacking and wireless communication security Road safety at the level of top-performing EU countries Safe and reliable braking behaviour in emergency situations Reliability of sensors, components, parts, wireless communication
Blind spots detected	Safety administration: logging of platooning-related accidents, traffic situations and driver status Privacy of truck drivers and logging data security IEEE 802.11p communications channel immunity to wireless signal jammers

TECHNOLOGY	
Challenges and open questions	Multi-brand platooning and standardised communication protocols Active platoons using signalling lights for visibility by other road users Platoon sequencing - accommodating trucks with various torque ratings, brake capacity and loading weights Wireless V2X communication reliability Full platoon control under all mixed traffic situations
Blind spots detected	Technology development roadmap disparities among truck manufacturers Effective and real-time estimation of safe inter-vehicle gap distance

LEGAL	
Challenges and open questions	Responsibility and liability in the event of an incident when control has been transferred to the system EU driving and resting times directive (EC561/2006) amended for driverless vehicles Cross-border access across European motorways Vehicle approval procedures harmonised across EU Vehicle following gap distance legislation harmonised across EU EU digital tachograph legislation (EEC 3821/85) amendment for driverless vehicles Insuring platoons: single or multiple underwriters
Blind spots detected	Platoon length (number of vehicles per platoon) harmonisation of legislation across EU Review labour rules to assess what is permitted for drivers while platooning

LOGISTICS BUSINESS	
Challenges and open questions	Identifying and guiding trucks that could meet-up together to dynamically form an ad-hoc platoon System cost and business case for SAE Level 1 or 2 platooning Platooning service provider to execute platoon formation from differing fleet-owners and brands Certification of trucking companies and drivers to promote confidence Logistics process integration to adapt to platooning (routing, inventory management, warehouse operations) Promote business benefits: explain the value of platooning Decide on the best method of platoon formation: scheduled or ad-hoc platooning (or a combination of both)
Blind spots detected	Minimal haul length required to efficiently allow diversion/detours to form platoons Use real-time data logistics control towers for ad-hoc platoon formation Urge shippers and carriers to make platooning more attractive by consolidating more loads in the same direction

USER ACCEPTANCE AND HUMAN BEHAVIOUR	
Challenges and open questions	Interaction with other road users, e.g. when entering and exiting motorways Driver acceptance by demonstrating safety and learning to trust the system Train other road users to accommodate platoons Driver task trade-off attention versus boredom Driver union boycott due to job insecurity Public opinion backlash against 'wall of trucks' Promote societal benefits through positive communication
Blind spots detected	Anxiety and exhaustion due to small gap distance Driver training and certification for platooning

INFRASTRUCTURE	
Challenges and open questions	V2X communication infrastructure available to enhance platooning Availability of (dynamically) dedicated lanes for platoons Road network segmentation for platooning Development of rules of conduct for platoon overtaking High definition maps and reliable real-time traffic information (Dynamic) gap distance determination depending on road network suitability
Blind spots detected	Auto-joining and leaving platoons at entry and exit ramps using ramp metering Use V2I communication in the event of unforeseen incidents, traffic accidents, road works, potholes suddenly resulting from bad weather conditions Platoon driving prioritised by traffic management, e.g. by green waves (V2X)

Functional safety is viewed both as the most important challenge and the crucial force for acceptance by drivers and society at large. Other challenges involving **Safety and Security** revolve around safe and reliable braking behaviour in emergency situations and reliability of sensors, components, parts, wireless communication. The falling costs of technology make redundant systems a possibility. Similarly, safety administration offers a relatively low cost option for legal and scientifical logging of platoon-related accidents, traffic situations and driver status. Insurance companies in particular see this application as a viable way forward in providing insurance and covering liability.

In the area of **Technology**, multi-brand platooning and standardisation of communication protocols is high on everyone's agenda as this holds the key to wide-scale adoption, as opposed to vendor lock-in situations limiting the attractiveness of truck platooning. Technology development roadmap disparities among truck manufacturers pose potential future challenges, according to some respondents. This is an interesting blind spot. To take an example, some truck manufacturers suggest that truck platooning drivers should start at SAE Level 3 (Conditional Automation), whereas other manufacturers stress that Level 3 should be skipped altogether. The argument is that technological development should jump straight from Level 2 to Level 4. Effective and real-time estimation of safe inter-vehicle gap distance is also considered important. This is partly related to the platoon sequencing problem in that gap distance is dependent on torque, braking power and loading of the trucks. Algorithms and technologies should be developed to tackle this problem, as with multi-brand platooning it is inevitable that heterogeneous platoons have to be formed all the time.

On the **Legal** front, many respondents see a major challenge in harmonising legislation across Europe e.g. for vehicle type

approval and gap distance between vehicles. Also, longstanding European directives for driving and resting times and use of the digital tachograph need to be adapted to driverless vehicles in order for truck platooning technology to reach its full potential. Furthermore, both directives should create possibilities to test/pilot a range of driving and resting times (initially exemption-based). But most of all, there are still open questions on how to insure platoons. Liability and responsibility change when transferring control from the human driver to the system. One suggested course of action is to assess whether single underwriters can help overcome these obstacles in the shorter term when mono-brand is still the predominant mode of platooning.

Most respondents see no significant barriers with **Logistics Business**. However, they do see a major challenge around the identity of potential platooning partners, and how to join them for ad-hoc platooning operations. Similarly, respondents agree that certification of drivers and transport companies could be crucial in building driver acceptance – especially for drivers in the following trucks. Despite the frequently stressed benefits of truck platooning, many parties are still unsure about whether the business case is strong enough in the short term, especially given the degree of uncertainty around the system cost of truck platooning.

Interaction with other road users is cited almost as often as functional safety. **User acceptance and human behaviour** form an important challenge. A potential public backlash about the 'wall of trucks' could be addressed by positive communication on the societal benefits of truck platooning. Communication apart, over the course of time technology can give a solution to this issue through automated gap making for other road users. It would also be interesting to see whether other road users should learn to accommodate truck platoons on the road, for instance when entering and exiting motorways.

Looking at the road, respondents question whether **Infrastructure** is ready to handle truck platoons. Whether or not lanes will be dynamically allocated to truck platoons, for instance at night, is still an open question. Traffic management could also prioritise truck platoons by means of green waves - making platoon driving more attractive. Also many respondents call for clear segmentation whereby platooning would be made possible, on the basis of road network suitability, high definition maps and reliable real-time traffic information. In some cases, the gap distance between vehicles could actually be (dynamically) changed to accommodate specific situations for instance in the vicinity of bridges or tunnels.

STAKEHOLDER CONSULTATION

Expected risks of truck platooning	Mitigating expected risks
Increased chance of accidents/disturbance in traffic flow due to behaviour of the truck platoon as a single vehicle entity	Requirements for visibility/recognition of the truck platoon, decoupling at on and off ramps, restrictions/recommendations on specific manoeuvres, prescribed following distance, maximum speed
Stakeholder consultation	
Increased wear and tear on roads/bridges due to the truck platoon as a single vehicle entity	Restrictions on maximum weight and division of load, decoupling at bridges
Stakeholder consultation	
Limitations of the platooning system in complex traffic situations	Decoupling in complex traffic situations like motorway junctions, traffic density, traffic jams, (mobile) road works and weather conditions, set procedures for truck drivers, prescribed following distance
A truck driver unfamiliar with the platooning system not knowing how to deal with the transition of control	
Stakeholder consultation	
Failure of the system in specific infrastructural situations: tunnels, slopes and curves	Decoupling at tunnels, x gradient values and x radius values of curves

CLOSING REMARKS

The sections above appear to show a large number of remaining challenges and open questions. However, not a few respondents state that it is quite feasible to overcome many of these barriers. Indeed, right now there is a powerful momentum and positive energy across the EU Truck Platooning Challenge network to start up real large-scale pilots and road testing. This means taking the next steps towards shaping a new reality in the Truck Platooning Vision 2025.

"While many challenges remain, there is a real momentum to start - now!"


REAL LIFE CASES
TRUCK PLATOONING
KORTE TERMIJN

6

FROM CHALLENGE TO REAL LIFE CASES

The European Truck Platooning Challenge landed in Rotterdam on 6 April 2016. From starting points in six European locations and driving through five countries, this gave an initial glimpse of a future where truck platooning would be an everyday phenomenon on motorways. For some truck platoons the journey took more than a week, while others started out just one day before. One fact can be established: everything went smoothly.

Although the Challenge was not a research project, driving cross border on public roads in mixed traffic provided a unique opportunity to learn about truck platooning in general and interaction with other traffic in particular. The acquired knowledge and experience within the Challenge is captured in this booklet. It provides valuable lessons learnt for future Real Life Cases with truck platooning. The booklet serves as an addition to the Storybook of the Challenge, which is available via the website www.eutruckplatooning.com.

In this booklet ACEA (yellow pages) and the authorities are looking back on the Challenge in order to move forward.

This chapter contains the synthesis of the previous chapters. It is not scientifically based, but more than an educated guess. This way of working embraces the philosophy of learning by doing. Demonstrations and/or tests are not followed by desk research or simulations to validate the outcome, but the conclusions and recommendations are, in the form of research questions, direct input for the next real life cases. And so, the feedback loop is shortened without ignoring preconditions including safety.

Building blocks for future Real Life Cases

Truck platooning is more than individual, connected trucks. It is a new mobility concept and needs development through active dialogue involving all stakeholders. The automotive and logistics perspectives differ from one another as do road or vehicle approval authorities.

The European Truck Platooning Challenge provided four sources with a lesson: nineteen exemptions, interviews with eighteen truck platoon drivers, aerial footage and a stakeholder consultation with 79 members of the European Truck Platooning Challenge community. Given that the analyses are not scientifically based the results need to be taken as a contribution to the discussion around the truck platooning concept development.

In this chapter the results of the analysis of the four sources are presented in three different ways:

1 Were the expected risks justified? In the second chapter five expected risks regarding traffic safety and infrastructure were identified based on the analysis of the requirements and recommendations of the nineteen exemptions. The results of the interviews with the drivers and the aerial footage are combined with these five expected risks.

2 Benefits of the truck platooning concept. The expected benefits of truck platooning are: improved traffic safety and throughput, fuel savings, reduction of emissions and lower labour costs. Given the results of the analysis, what can be said about these expected benefits?

3 The European Truck Platooning Challenge is meant as a starting point for building cross border truck platooning corridors. The analysis of the exemptions showed that the national approaches differ substantially. The question is where does one start to get closer to cross border harmonisation and interoperability – obviously, selecting focus points is important.

This booklet is aimed at Real Life Cases upcoming in the next two years. With testing of on-the-fly platooning not expected in the next several years, these results are confined to scheduled platooning. Unlike scheduled platooning, with the concept of on-the-fly platooning, trucks can randomly form platoons, although on-the-fly platooning does involve other challenges than the concept of scheduled platooning.

Were the expected risks in the exemptions for truck platooning justified?

Although the expected risks were justified, in general, the exact conditions for mitigation measures require evaluation, as on some occasions the requirements were seen to be counterproductive.

First expected risk

Increased chance of accidents/disturbance in traffic flow due to behaviour of the truck platoon as a single vehicle entity.

Truck platoons merging into the traffic flow introduce a new/different factor. This applies to platoon drivers and other traffic. The truck drivers in a platoon feel part of a larger entity and act accordingly, taking into account the following and/or leading trucks. There seems to be a tendency to keep the platoon together as much as possible and when initiating or performing certain manoeuvres, such as overtaking or changing lanes, the drivers need to realise that they are part of the platoon and so need more time and space than a single truck.

Some requirements, as formulated in the exemptions (or accompanying code of practice), may lead to disturbances of

the traffic flow, in particular in the vicinity of on- and off-ramps. For example, the stance on decoupling as a prescribed mitigation measure may need to be reconsidered, on the basis of experience during the Challenge. A less stringent approach may be more suitable for the variety of traffic flow conditions platoons may encounter.

A further issue is the difference between the actual driving speed of single trucks and the speed limit for truck platoons imposed by the authorities in the exemptions. The truck platoons strictly complied with the speed limit resulting in platoons driving slower than other trucks whereby these overtook the platoons.

A possible suggestion for the future would be to have platoons blend in as much as possible by minimising the speed gap between them and other traffic and/or trucks.

Optimal headways in a platoon can be realised by taking various angles into account. For example, there is a difference between vehicle safety and traffic safety. From the vehicle safety angle one could argue that a wider distance between two platooning trucks is better. Meanwhile, from the traffic safety angle one could also argue that overly long distances increase the number of cut-ins by other traffic, including by other trucks. This disrupts the traffic flow and can have a negative impact on traffic safety, as was observed in various situations during the Challenge.

Second expected risk

Increased wear and tear on roads/bridges due to the truck platoon as a single vehicle entity.

Two phenomena are considered in regard to increased wear and tear on the infrastructure. The first one is a change in load distribution within the truck platoon due to varying headways. The assumption is that shorter headways mean a heavier impact on bridges. Second is the increased chance of rutting when platoons drive on a fixed track within the lanes. For this to occur the trucks must have lateral assistance, which was not the case during the Challenge.

No supporting information was obtained for either phenomenon as the duration was too short and no method of actually gathering empirical evidence was applied.

Third and fourth expected risk

Limitations of the platooning system in complex traffic situations.
A truck driver unfamiliar with the platooning system not knowing how to deal with the transition of control.

Even though the platooning systems function well under different conditions, several drivers (people who are very familiar with the limitations of the equipment) indicated that in certain situations they would decouple at their own initiative.

Fifth expected risk

Failure of the system in specific infrastructural situations: tunnels, slopes and curves.

No empirical evidence supporting this expected risk was identified during the Challenge, with the exception of two driver statements to the effect that they would decouple at fly-overs and that slopes were more stressful than short headways.

What are the benefits of the truck platooning concept?

In general, the expected benefits will materialise apace with longer, uninterrupted platooning.

Improved traffic safety

Truck platooning has the potential to increase traffic safety by reducing the number of head-tail collisions due to the ACC and/or emergency braking functionality. This applies both to the actual platooning trucks and between platoons and preceding traffic. No changes are expected for traffic following the platoons. The safety effect is even greater for platooning trucks, as the fact that they are connected enables a faster mutual reaction. Moreover, improved compliance with speed limits – as is the case with platooning trucks – also increases traffic safety.

Improved throughput

Less frequent decoupling by platoons increases the stability of traffic flow, and enhances throughput. Platoons can better utilise existing road capacity if headways are shorter than with non-equipped trucks. However, during the Challenge it was observed that quite some non-equipped trucks actually drive closer together than platooning trucks, but safety levels are lower and this can lead to (predominantly head-tail) accidents. The resulting congestion can negatively affect throughput.

Fuel savings and reduction of emissions
Exact expectations of reduced fuel consumption in platooning trucks depend on several factors including (short) headways, position in the platoon, percentage of time trucks can actually platoon, weather conditions and layout of the network (slopes, curves, etc.). Fuel savings were not monitored during the Challenge. However, in general the opening sentence of this section also applies here.

Lower fuel consumption due to the platooning concept means that associated emissions are likely to reduce apace.

Lower labour costs

Three potential reductions in labour costs are expected in the future.

- Alternative use of driving time could allow additional tasks to be performed, and may increase driver efficiency

- Appreciate driving time as resting time when automation levels increase
- When no driver is needed in a following truck

However, the interviews suggested that the following task was considered more intensive than driving a normal truck. The relevant level of automation may play a role here; this was level 1 for the Challenge, meaning that there was no lateral support.

Where do we start on closing the gap towards cross border harmonisation of truck platooning?

In the Declaration of Amsterdam (14-15 April 2016) the member states, the European Commission and industry underlined the importance of cooperation in the field of connected and automated driving. One of the objectives is to work towards a coherent European framework for the deployment of interoperable connected and automated driving.

This evaluation report cites numerous examples to the effect that a debate is needed between all stakeholders involved in order to build cross border truck platooning corridors. No one stakeholder can develop the concept of truck platooning in isolation.

The authorities involved in the European Truck Platooning Challenge mainly followed their own procedures and assessment philosophies. In many countries the European Truck Platooning Challenge accelerated development of procedures for self-driving vehicles in general and truck platooning in particular. Some countries that had minimal experience with assessing applications for truck platooning, contacted their neighbours. The European Truck Platooning Challenge resulted in an active network that can be deployed in future steps.

All countries took the European Truck Platooning Challenge as a one-off demonstration. In the event of a long-term test most of them would assess applications differently.

4 X HARMONISATION ISSUES & 4 X BOUNDARY CONDITIONS TO BE DISCUSSED

Some of the issues around the truck platooning concept represent unsolved harmonisation issues for road freight transport in general. This applies to: following distance, maximum speed, maximum gross weight and driving bans. The reason for lack of harmonisation is more or less due to political factors.

This needs to be taken into account when identifying focal points for harmonisation. Harmonisation on all aspects might be not necessary in the phase of real life cases. The optimal outcome of the truck platooning concept for both the transport sector and for society should be central within the process of harmonisation.

From the angle of the authorities, four elements of the truck platooning concept are non-negotiable or would be problematic to alter when crossing borders:
1. Driver
2. Vehicle characteristics
3. Load
4. Settings of the system

Agreement will have to be reached here in dialogue between the authorities and the stakeholders.

Moreover, there are preconditions on which depend the success of real life cases. Both harmonisation issues (numbered) and preconditions (cadres) are presented below.

1. Driver

The exemptions required experienced drivers who were familiar with the platooning system. Based on this evaluation report it is reasonable to call this a fair requirement.

Two other driver requirements were:
- Drivers should be employed by the truck brand;
- The following trucks should have a co-driver.

The reasoning behind these two requirements is unclear. They make it more difficult for transport companies to join Field Operational Tests. It also makes the pilots very expensive because of high labour costs.

Truck platooning needs pioneers and cross border initiatives

The European Truck Platooning Challenge was a combined achievement mainly involving OEMs and national/federal authorities. Further development of the concept of truck platooning will require the involvement of the end users: shippers and hauliers. The challenge is to identify companies willing to play a pioneering role.
Preconditions for the large scale adoption of truck platooning are: multi-brand platooning, standardisation of communication protocols and certification of drivers and transport companies to boost acceptance by the drivers.

The absence of cross border initiatives will slow down the harmonisation process.

2. Vehicle characteristics

As was required by exemptions, during the European Truck Platooning Challenge some truck platoons were recognisable by texts and flashing lights. Some of the truck drivers indicated that they prefer to be recognised as a truck platoon, in order to avoid miscommunication with other road users.

A discussion must be started-up on the positive and negative effects of recognisability of the truck platoon. The issue is similar to discussions on the recognisability of High Capacity Vehicles (like EMS-vehicles) in countries such as Sweden and the Netherlands and one should examine the relevant discussions here.
A future-proof solution should take into account multi-brand and on-the-fly platooning.

Current infrastructure as a starting point

Clear segmentations are needed to show where platooning can be operational, on the basis of road network suitability, high-definition maps and reliable real-time traffic information. Looking at Real Life Cases in the short term, the current state of infrastructure should be a given. The question is still open as to what extent the infrastructure needs to be adapted to automated and connected driving in general, and truck platooning in particular. Real Life Cases could help answer this question.

In the longer term, traffic management should make a determined effort to ensure that driving in a platoon is more attractive by prioritising platoons, using green waves or dynamical allocation of lanes.

3. Load

Not much can be concluded from this evaluation report in regard to the load. This is a politically charged issue. Some exemptions impose a maximum gross weight of 20 Tonnes and make decoupling at bridges mandatory. Sweden has indicated that future Field Operational Tests will require a longer following distance between platooning trucks on bridges.

More research is needed on the impact of truck platooning on the wear and tear to pavements and bridges. Some negative effects can be lessened by system settings – like not driving in the same track as the vehicle in front.

The load will also influence braking.

Clarity on liability of the road authorities

Liability plays a role between OEM and road haulier, but the liability of the road authority could also change. All road authorities are in the same situation. The position countries take on liability has consequences for the discussion on the adaptation of the infrastructure to automated and connected driving. Example : if the quality standards for road markings are raised, road authorities will be obliged to maintain these markings in line with these standards. Whether or not this is realistic will need to be debated at the European level.

4. System settings

If the settings of the platooning systems are flexible and can be changed when crossing borders, differing requirements between countries will not be an issue. The necessity or desirability of differences in requirements is open to discussion, but in technical terms cross border truck platooning is feasible.

In the first instance the discussion should focus on settings that are not flexible. Example: is it technically possible to alter following distances when required, or to install a limited number of following distances, or is it necessary to harmonise the following distance for truck platooning?

Monitoring and transparency

The learning by doing approach aims to shorten the feedback loop. Open questions are researched by monitoring real life cases. This accelerates learning. Transparency is a precondition. It should be made clear which data is indispensable in answering research questions with respect to competitive information. Another precondition is that research results are exchanged between countries.

MEET THE COMPILERS OF THIS BOOKLET LESSONS LEARNT

Although not a research project as such, the EU Truck Platooning Challenge did provide a unique opportunity to gain experience and accumulate knowledge around cross border truck platooning on public roads, with mixed traffic. This booklet therefore contains building blocks for future European truck platooning corridors and initiatives.

The authors have taken the greatest possible care in compiling the contents of this booklet and trust that it will contribute to the further implementation of truck platooning in Europe.

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www.eutruckplatooning.com
www.rijkswaterstaat.nl/english
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The views and conclusions expressed in this report are those of Rijkswaterstaat, RDW and the Dutch Ministry of Infrastructure and the Environment. They are based on analyses performed exclusively on the basis of information collected by the authors. While these views and conclusions may constitute a starting point for further discussions, which will be welcomed by ACEA and its member companies, they may or may not reflect the official position of ACEA or any of its member companies.

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