PREPARING TAMPERE-HELSINKI HIGHWAY FOR PLATOON DRIVING

WP 4, Activity 2
Version: Final
Date: 18/6/2021

Jukka Siren
Ramboll

CONTENT

1 SUMMARY

Convoys, platoons serving the last mile of combined transport chain are an already occurring phenomenon. For example, platoons with two to four combinations are a common sight on the Tampere Helsinki highway. It is essential to consider how their efficiency, environmental friendliness, safety and drivers' working conditions can be improved. It has an impact on the competitiveness of the entire combined transport chain.

Leading truck providers set out to develop platooning technology in the mid-2010s and had high expectations. Afterwards, it could be estimated that the hype related to autonomous driving peaked in 2015-2018. Platooning got its share of this. Some even expected platooning trucks to be the first self-driving vehicles. Perhaps it can be said that platooning suffers from this over-marketing - it is perhaps a little difficult to see the potential of platooning technology.

This report provides an overview of the expectations and current state of platooning technology, introduces the levels of platooning technology - platooning as a support function and platooning as an autonomous function. One of the key challenges in platooning is that previously developed business cases are based on platooning as an automatic function level technology that is not yet available. COMBINE WP 4.2 has met this challenge and developed a business case based on available platooning technology - platooning as a support function.

In line with the guidelines of the European Union Mobility Package, COMBINE WP 4.2 proposes that the platooning as a support function should be seen as an advanced driver assisting system, which would allow drivers using it flexibility in driving and rest times. As is well known and also documented by the police during the heavy traffic monitoring weeks - the speed of heavy traffic is in practice 85 km / h, although the maximum allowed speed is 80 km / h. The situation is partly due to the rigidity of driving and rest times, a small overspeed is more permissible than a slight deviation from the driving and rest times. COMBINE WP 4.2 suggests that in return for the flexibility of driving and rest times, drivers should commit to a maximum speed of 80 km / h. Monitoring can be arranged automatically – digital control of the smart last mile - with the help of modern fleet management systems - notification of speeding is sent by e-mail to the supervisory authority automatically. As described above, two main platooning targets can be achieved: a 5% reduction in fuel consumption and CO2 emissions, as well as driving and rest time flexibility for drivers.

In addition, 80 km / h and flexibility in driving and rest times can open up opportunities in the same direction as ships 'slow steaming. Engines - power and size - are likely to be reduced, and emission reductions are expected, as ships' slow steaming experience shows. Opportunities to use LNG and electric motors are likely to increase.

The last mile digital control also includes additional possibilities. Digital control of the smart last mile enabled by modern fleet management systems may allow, for example, the controlled use of HCT combinations on certain combined transport last mile routes.

2 FOREWORD

The chain - including the combined transport chain - is as strong as its weakest link. Efforts should be made to develop all links of combined transport, including last mile road transport. Inefficient last mile road transport may weaken the competitiveness of the entire combined transport chain. Effective last mile road transport measures that have been shown to improve the competitiveness of the entire combined transport chain have already been put in place in Europe, such as *Exemptions from the driving ban on weekends and bank holidays and from the holiday driving ban* and *Maximum permissible weight increased to 44 tons for initial and terminal road haulage*.

At the beginning of the COMBINE project, platooning technology was generally expected to be the next major way to make the last mile more efficient. In a few years, platooning technology was expected to provide efficient and easy-to-apply solutions to make the last mile more efficient.

Automatic driving based on platooning technology was first expected to take over vehicle distance control. It was expected that the automatic distance control of the platooning technology would shorten the distance of trucks driving on the road by up to approximately ten meters, thus reducing the air resistance of convoying combinations and reducing fuel consumption and CO2 emissions by an average of 5 percent per combination. The business case based on CO2 and fuel savings was assumed to be in production use in the early 2020s.

By 2025, a level of automatic driving was believed to reached where only the driver of the first combination would drive actively and the three to five combinations behind would follow the first automatically controlled by platooning technology. This would have brought significant flexibility to drivers' driving and rest periods. Thus, the business case would have been be based on drivers' diving time flexibilities.

From these starting points, the COMBINE activity 4.2 *Preparing Tampere-Helsinki Highway for Platoon Driving* was expected to be a rather straightforward project, in which ready-made technological solutions and business models enabling automatic driving would be introduced.

However, this activity became much more versatile and extensive than expected when it became clear that the first versions of platooning technology would not be automatic but driver-supporting systems. The ready-made business models were based on automatic driving platooning solutions. The COMBINE project was offered the opportunity to develop a business model enabled by a driver-supporting system together with leading truck providers and the Finnish authorities. This significantly increased the challenge for this activity.

The Covid-19 situation has affected the project because leading truck providers had to temporarily shut down their operations and product development, postpone their multinational platooning tests and the launch of new Fleet management systems. Some key systems related to this activity have been on the market since early 2021 instead of middle 2020s.

Despite the challenges, COMBINE WP 4.2 is ready to present a solution and business model that can be used to implement Platoon Driving on the Tampere-Helsinki highway with the available driver supporting systems. The proposed solution will deliver the target of 5% savings in CO2 emissions and

fuel costs, as well as a proposal to increase the flexibility of driving and rest times in the spirit of the EU Mobility Package.

The solution relies heavily on Fleet Management systems launched in early 2021, which provide broader opportunities for Smart Last Mile solutions and digitization of combined transport. Smart and Digital Last Mile solutions can improve the competitiveness of the entire combined transport chain.

3 BACKGROUND AND OBJECTIVES

According to Eurostat, over 75 % of inland cargo transport within the European Union is transported by trucks. This is about 1,75 billion tonne-kilometres per year (2018). As stated in the White Paper on Transport, *„It is therefore important, besides encouraging alternative transport solutions (rail, waterborne transport), to improve truck efficiency, via the development and the uptake of new engines and cleaner fuels, the use of intelligent transport systems and further measures to enhance market mechanisms“*.

Effective last mile road transport measures that have been shown to improve the competitiveness of the entire combined transport chain have already been put in place in Europe, such as *Exemptions from the driving ban on weekends and bank holidays and from the holiday driving ban* and *Maximum permissible weight increased to 44 tons for initial and terminal road haulage*. The competitiveness of the whole combined transport chain can be further developed by allowing, in a similar way, more means to make last mile road transport more efficient. The COMBINE WP 4 „Capacity building for sustainable last mile transport“ focuses on implementation of innovative solutions for road transport such as platooning and longer, heavier, self-driving, electric or LNG trucks.

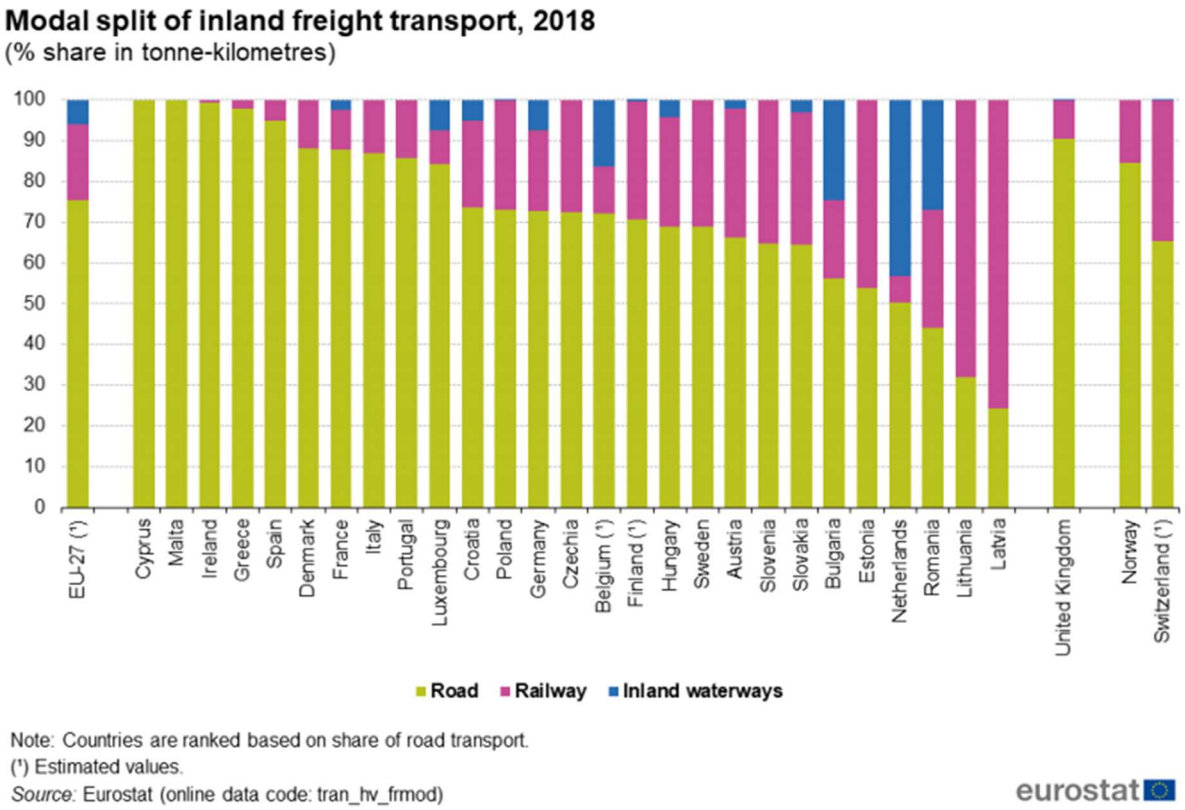


Figure 1. Modal split of inland freight transport 2018 (Source: Eurostat)

The European Union's climate targets set strict emission targets for member states, as the example of Finland shows below. The electrification of transport will certainly solve some of the problems, as passenger cars and urban distribution traffic can be handled by electricity. The challenge is to replace fossil fuels in the long-haul heavy goods road transport. The range of electric trucks limits the possibilities for long-distance heavy transport. Hydrogen is expected to provide a solution to this, but the large-scale entry of hydrogen trucks into the market is likely to take at least a decade.

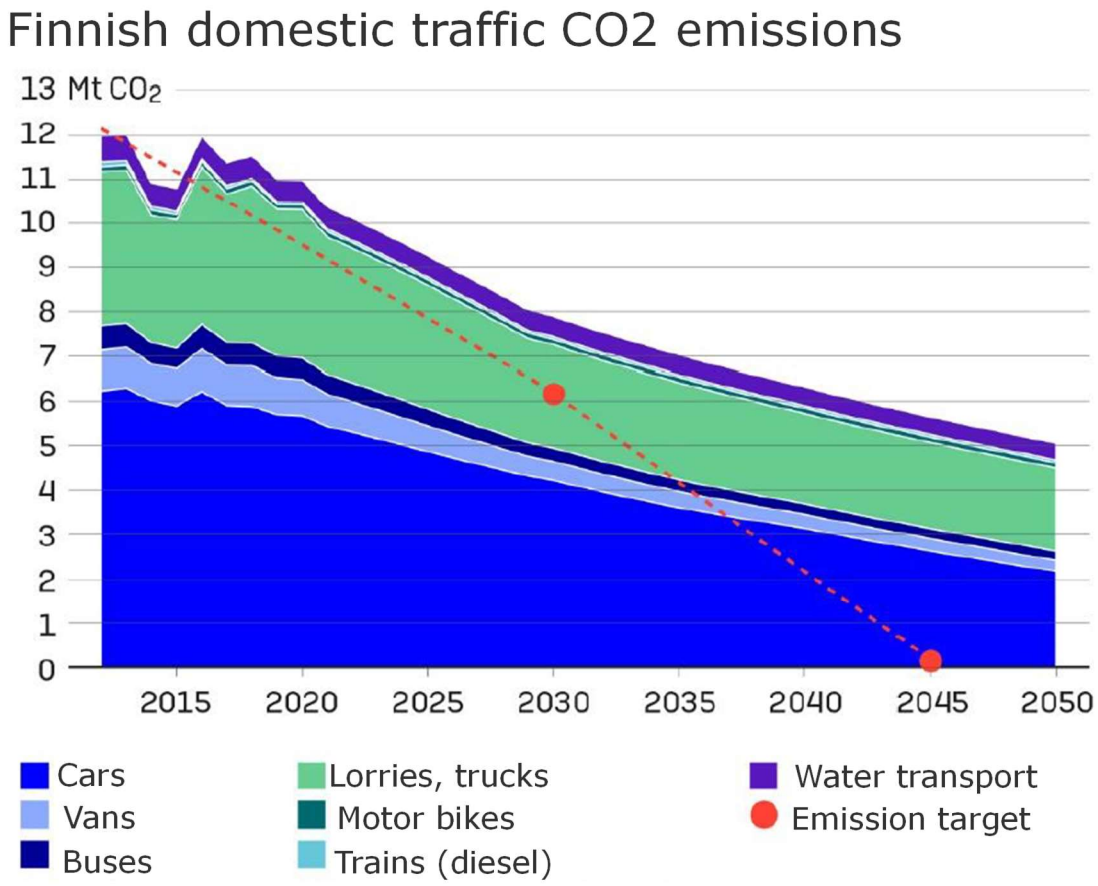
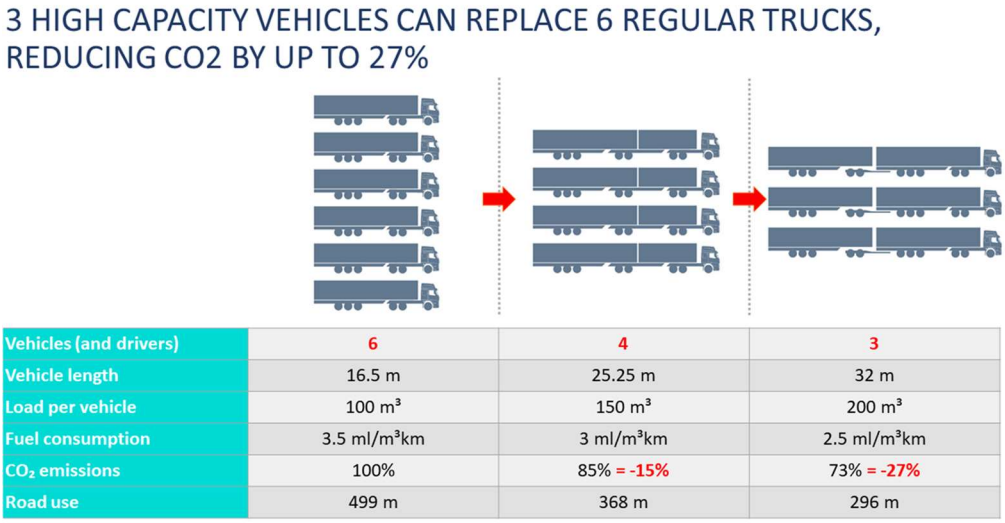


Figure 2. Finnish domestic traffic CO2 emissions, basic forecast and emission target. (Source: Finnish Ministry of Transport and Communications)

This further emphasizes the importance and potential of combined transport. Actions on the masses and dimensions of combinations as well as driving and rest times can significantly enhance the competitiveness of last mile transport, and thus the competitiveness of combined transport as a whole. Exemptions from the driving ban on weekends and 44 tons for initial and terminal road haulage are steps in the right direction.

Finland has developed last mile transport systemically for years. High Capacity Transport (HCT) testing programme started in 2013 and HCT legislation was implemented on the 21st of January in 2019. HCT vehicles can reduce CO2 emissions by up to 27 % compared to normal trailer combinations. Also, driver work productivity increases significantly. Allowing HCT combinations for initial and terminal road haulage would increase the competitiveness of the entire combined transport chain.



Vehicles (and drivers)	6	4	3
Vehicle length	16.5 m	25.25 m	32 m
Load per vehicle	100 m^3	150 m^3	200 m^3
Fuel consumption	3.5 ml/m^3km	3 ml/m^3km	2.5 ml/m^3km
CO_2 emissions	100%	85% = -15%	73% = -27%
Road use	499 m	368 m	296 m

Figure 3. High Capacity Vehicles can reduce CO2 emissions by up to 27 % (Source: Cider L, Larsson L, HCT DUO-2 project)

Figure 4. HCT trucks (34,5 m / 76 tons) have been a successful part of daily business for over two years in Finland. (Photo credit: Jukka Siren, Ramboll Finland)

The main ambition of this study is to follow and repeat the success of the HCT implementation in Finland by defining new technologies and business models which will improve the efficiency of last mile transport and also propose practical ways to implement them. At the start of the COMBINE project, platooning technology was generally expected to be the next major way to make the last mile more efficient.

4 FINDINGS

4.1 What is platooning?

As defined by the Sweden4Platooning project:

- Platooning means that several trucks are connected wirelessly to a vehicle train. The driver in the first truck drives as usual while the others follow automatically. This allows driving closer to each other which reduces drag and saves fuel.

- Platooning improves
  - safety
  - traffic flow and road capacity
  - fuel economy and reduces CO2
  - transport efficiency with fully automated follower trucks (driver in the first vehicle only)

Sweden4Platooning -project has defined platooning variants. Only the first variant – ACC (Adaptive Cruise Control) – is widespread, commercially available and already in production use. Other variants are not yet commercial products.

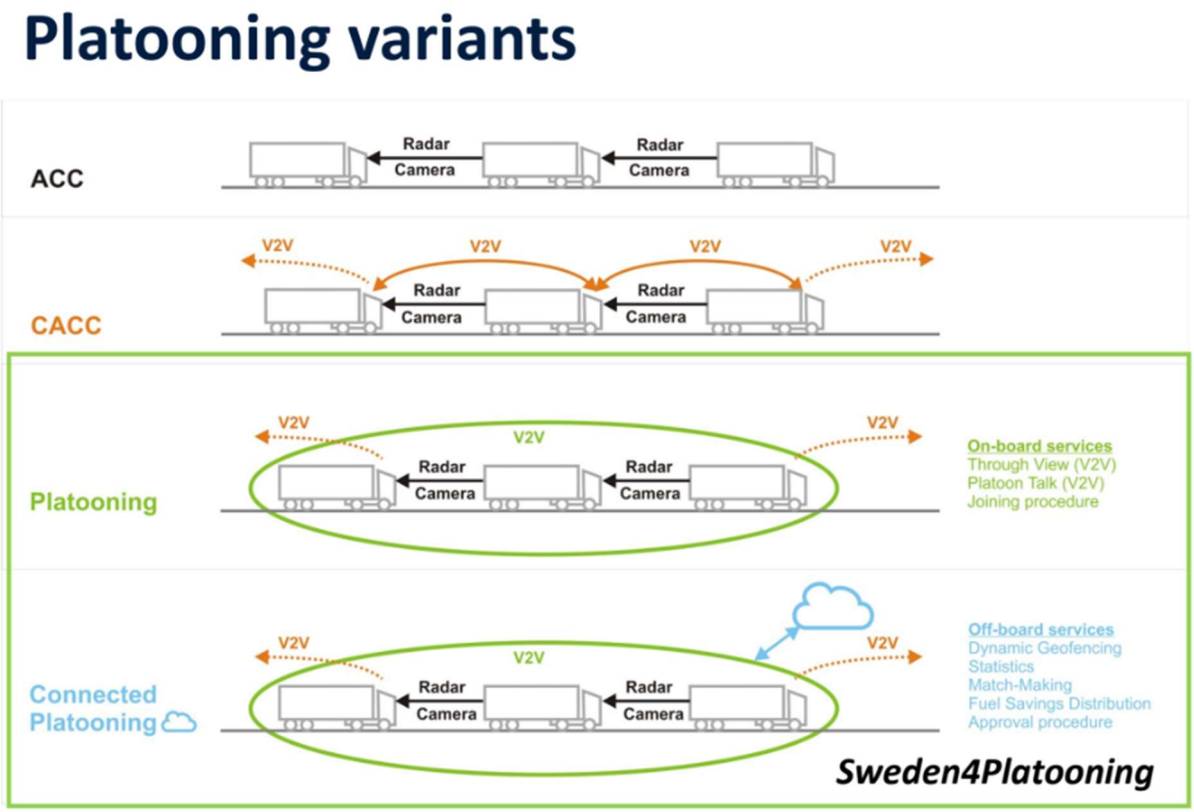


Figure 5. Platooning Variants defined by the Sweden4Platooning project

Mere communication between successive vehicles is not enough. Platooning requires an information system in the background for two reasons:

- The benefits of platooning (fuel savings, driver time savings) focus on the following vehicles, the first-drive vehicle does not benefit. If the platoon consists of vehicles from several transport companies, the benefits must also be compensated for the first-drive vehicle (fuel savings distribution). This should happen in a fleet management system that supports the platooning of vehicles in the background.

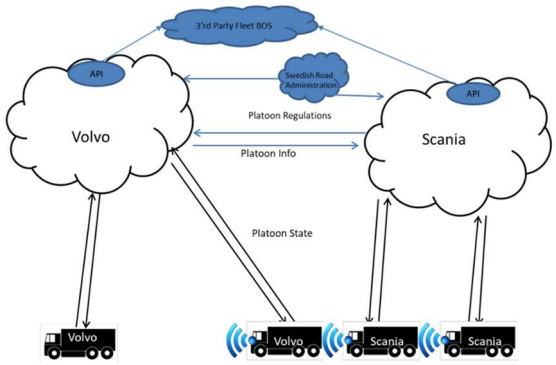


Figure 6. Fleet management systems supporting platooning (Source: Alexander Johansson KTH)

- A background system is also needed to form platoons. Of course, platoons can be formed on an ad hoc basis when vehicles by chance drive in succession on the road. However, the use of platooning can be significantly increased with a back-end system that brings together, for example, vehicles departing from the same hubs and driving the same routes (match-making support).

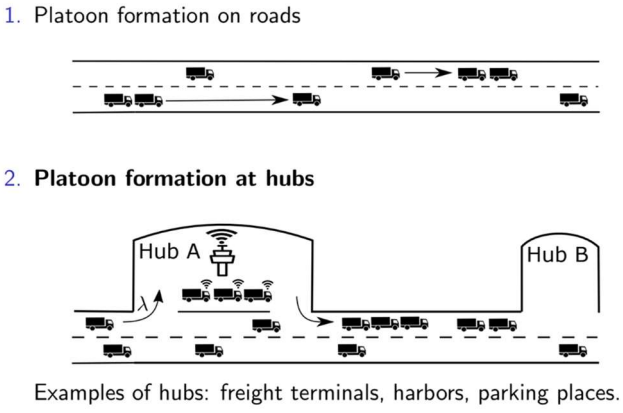


Figure 7. Platoon formation (Source: Alexander Johansson KTH)

COMBINE WP 4.2 has carefully followed the launch of both new tractors and fleet management systems. Covid-19 has caused a delay and some of the new products came on the market in early 2021. COMBINE WP 4.2 has adapted to the changed schedules. The latest fleet management systems offer interesting opportunities for last mile efficiency but features that centrally support platooning (e.g. fuel savings distribution, match-making support) are not yet available in commercial fleet management systems.

4.2 More challenging than expected

The COMBINE project began in January 2019 and the expectations concerning autonomous vehicles – both cars and trucks – were high. Especially the public discussion was in a hype mode. Platooning technology was expected to provide efficient and easy-to-apply solutions in a few years to make the last mile more efficient. For example, Smartport.nl -project driven by the Port of Rotterdam estimated that „*Truck Platooning would be a game changer in Hinterland logistics: by 2020, approximately 100 platoons per day will depart from Rotterdam's port area. This would significantly reduce fuel costs and CO2, improve social benefits of drivers, increase road safety and improve traffic flow.* „

Autonomous trucks were expected to roll out in four waves and the waves were generally expected to arrive quite fast. McKinsey expected full autonomy already in 2027.

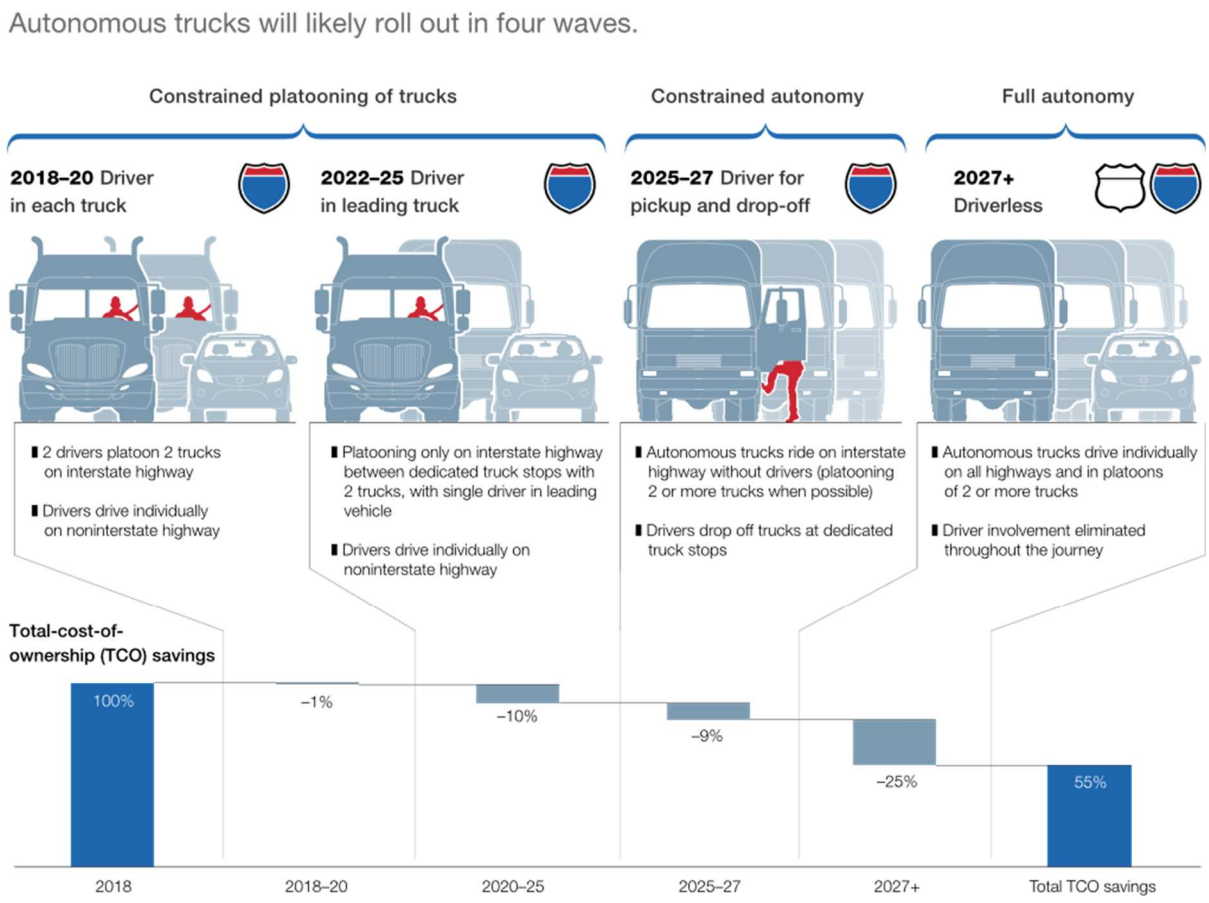


Figure 8. Autonomous trucks will likely roll out in four waves (Source: Route 2030: The fast track to the future of the commercial vehicle industry, September 2018, McKinsey.com)

During the year 2019, the public discussion concerning autonomous vehicles changed:

- *„Automated driving is a bit more challenging technically than we originally thought*"– Håkan Samuelsson, CEO, Volvo
- „Right now, component manufacturers and venture companies working on the technology are revising their timeline for autonomous vehicles deployment significantly" – Shigeki Tomoyama, EVP, Toyota.

Although platooning is more challenging than expected, gradual automation of driving systems continues and there is a need to be prepared for that. This is also mentioned in the EU Mobility Package published in year 2020:

„Rapid technological progress is resulting in the gradual automation of driving systems which require less or no direct input from the driver. To address those changes, current legislation, including rules on driving and resting times, may need to be adapted in order to guarantee road safety and a level playing field and to improve working conditions, whilst enabling the Union to pioneer new innovative technologies and practices. Therefore, the Commission should submit a report evaluating the use of autonomous driving systems in the Member States, including the benefits of autonomous driving technologies. That report should be accompanied, if appropriate, by a legislative proposal."
(Source: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2020:249:FULL)

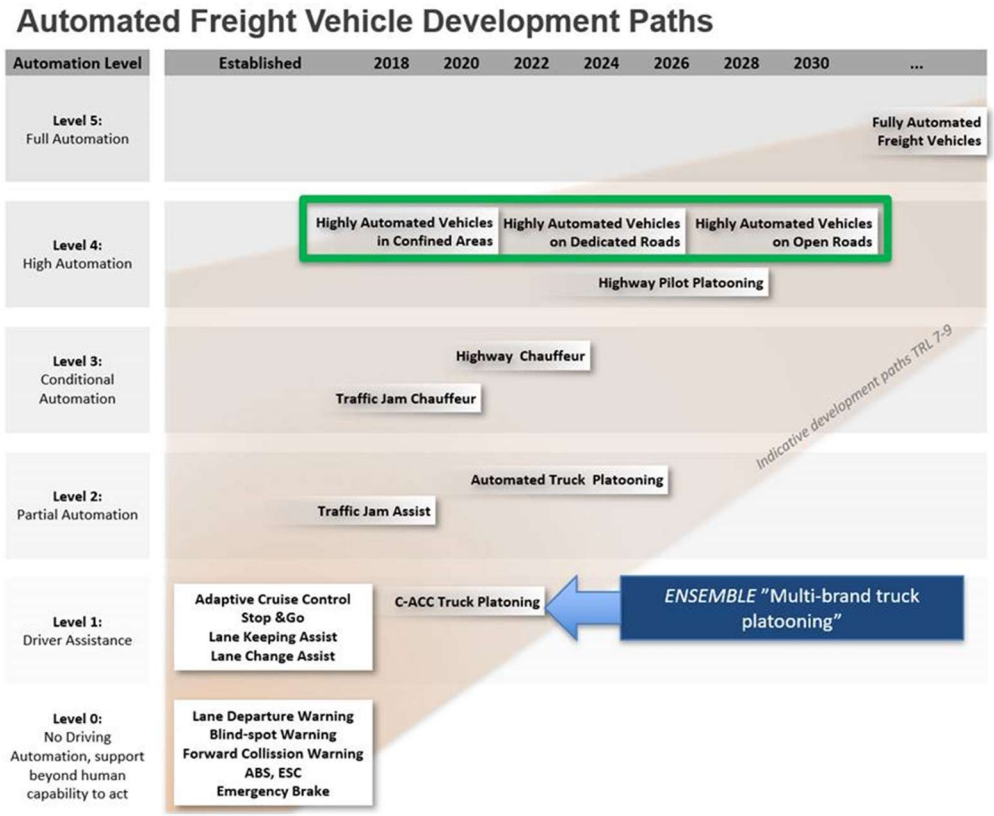


Figure 9. Big picture: Gradual automation of driving systems continues and there is a need to be prepared (Source: Ensemble-project)

4.3 Fuel savings in theory and practise

Sweden4Platooning project started with high expectations for fuel saving. The results presented at the Sweden4Platooning Final Conference on the 11th of March 2020 in Stockholm indicate the fuel savings in theory and practise.

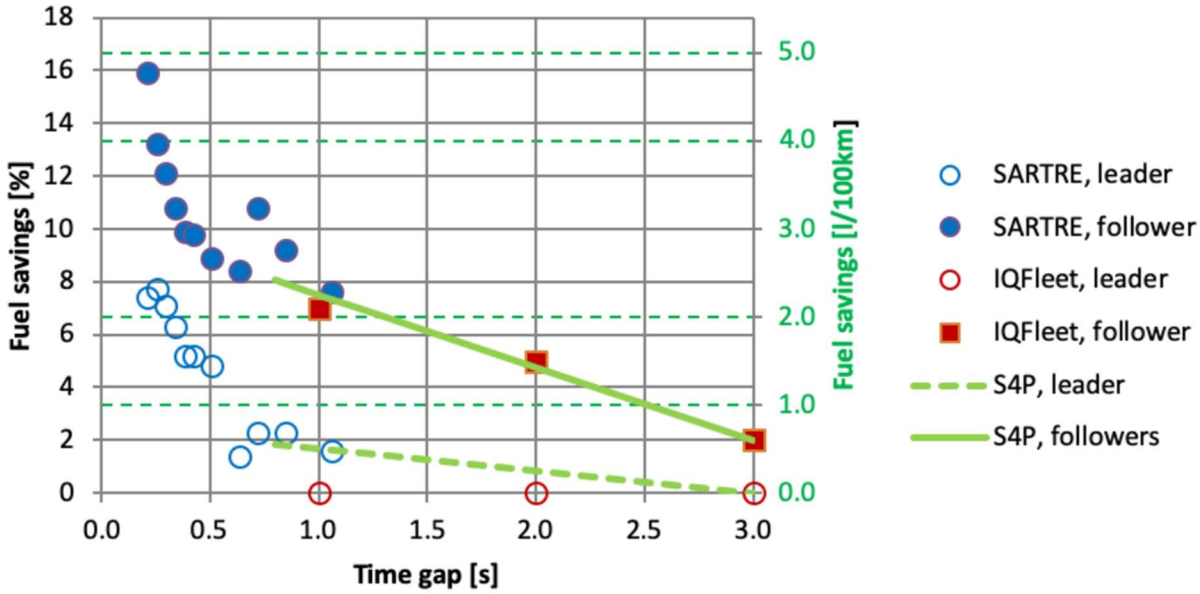


Figure 10. Results of Sweden4Platooning: Assumed absolute fuel savings (green lines) for analysis together with measured relative savings from SARTRE and IQFleet project, plotted together assuming a nominal 30 l/100km absolute fuel consumption.

As Figure 10 shows, fuel savings are realized if the distance (time gap) between platooning vehicles is as short as possible, for example less than a second. At a speed of 80 km/h, a distance of one second means 22 meters. It was earlier estimated that the platooning gap distance could be even 0,3 second (6,6 meters) by 2020. This would mean that

- the "Follower" could achieve savings of 4–5 litres (13-17 %) per hundred kilometres
- and the "Leader" could achieve savings of 1,7–2,2 litres (6-7 %) per hundred kilometres.

Unfortunately, such a short distance is not yet possible in production use for safety reasons and safe distance is still close to three seconds (66 meters) while driving 80 km/h. Practical test results of Sweden4Platooning project show that:

- the "Follower" could achieve savings of 0,6–2 litres (0,6-2 %) per hundred kilometres
- and the "Leader" could achieve savings of 0–0,6 litres (0-0,6 %) per hundred kilometres.

4.4 Status of platooning

As defined by *Platooning Ensemble* project, platooning has two relevant levels:

- platooning as a support function (including longitudinal control, drivers in all vehicles)
- platooning as an autonomous function (both longitudinal and lateral control, a driver only in the first vehicle, following vehicles autonomous and unmanned)

It seems, that the first versions of platooning technology will not be autonomous but driver-supporting systems. First benefits of platooning will focus on

- safety
  - safer distance control compared to current driving conditions
  - faster reaction to potentially dangerous braking situations
- traffic flow and road capacity
  - more stable string of following trucks,
  - standard communication protocol between all trucks on the road to improve awareness for other cooperative vehicles

Some benefits concerning fuel economy and CO2 reduction will also be reached, but more moderate than expected, as current technology does not fulfil all the safety requirements that are needed for the very short time gap (less than a second) and very short distance (less than 22 meters between the vehicles) platoon driving.

Foreseen benefits of autonomous platooning would be significant especially if the following vehicles could be autonomous, i.e. driver would be needed only in the first vehicle. This would require Automation Level 4 (autonomous function), which is not expected to be reached during the nearest years. In any case, this long-term vision can be a relevant step towards full automation and driverless vehicles – even if it will not happen as fast as was expected a few years ago.

The ready-made platooning business models were based on automatic driving platooning solutions. The COMBINE project was offered the opportunity to develop a business model enabled by a driver-supporting system together with leading truck providers and the Finnish authorities. This significantly increased the challenge of the activity.

Despite the challenges, COMBINE activity 4.2 is ready to present a solution and business model that can be used to implement Platoon Driving on the Tampere-Helsinki highway with the available driver supporting systems. The proposed solution will deliver the target of 5% savings in CO2 emissions and fuel costs, as well as a proposal to increase the flexibility of driving and rest times in the spirit of the EU Mobility Package. In this solution, driving and rest times play a key role.

5 SMART LAST MILE

5.1 Smart and flexible driving and resting times for the smart last mile

The final conference of the *Sweden4Platooning* project gave a clear message to focus on driving time issues while developing platooning business models further. COMBINE WP4.2 took their advice and has had intensive discussions on driving and rest periods with the Finnish transport authorities, leading truck manufacturers and drivers' associations.

The European Union Member States have common rules for driving and rest times. This is a good thing for many reasons: work situation for drivers, road safety and fair competition between hauliers.

The rules are well defined for authorities to penalize drivers and hauliers that break these rules. The basic rule is that a 45-minute rest is required after 4,5 hours of driving. After 9 hours, the working day is over. But several add-ons are valid. You can prolong driving time one week, but you need to shorten it the coming weeks.

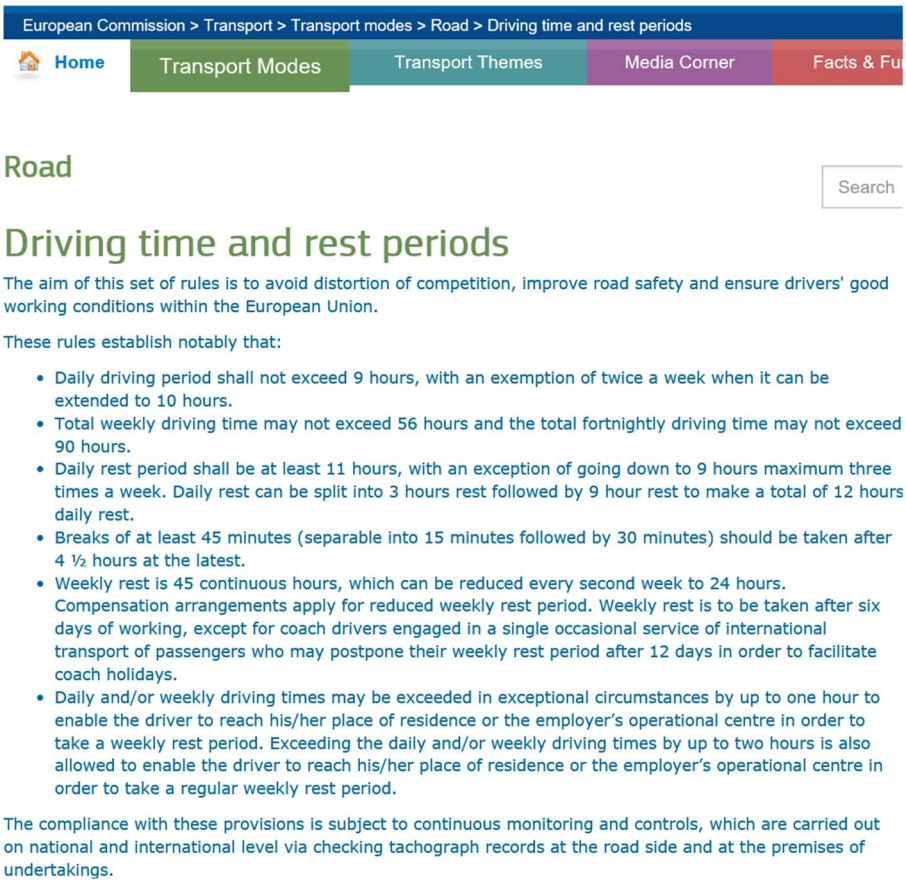


Figure 10. Driving time and rest periods

(Source: https://ec.europa.eu/transport/modes/road/social_provisions/driving_time_en)

The driving and rest times are necessary but also somewhat static. Many drivers detest the tachograph and the accompanied drive and rest time which is perceived as a modern leg iron for them. When a

road is blocked by an accident for a prolonged time many drivers are forced to stop and take a rest in a remote place far from the final destination or a suitable rest area.

Violation of the rules on driving and rest periods is also common, a matter that comes up repeatedly in the police's heavy traffic enforcement. For example in Finland, 15 to 20 percent of vehicles inspected by the police violate rules on driving and rest time. This is important not only in terms of road safety but also for fair competition: an illegal competitive advantage is achieved by violating driving and rest periods. Even during the inspection weeks announced in advance by the police, driving and rest time violations are caught on every fifth vehicle inspected.

Speeding is also very common. Exceeding the 80 km/h limit is very common, and the average speed for heavy traffic is practically around 85 km/h. Speeding impairs road safety, but also increases fuel consumption and CO2 emissions. The situation is partly due to rigid driving and rest time rules. When the driving time is not flexible, any delays in traffic that are independent of the driver are compensated by speeding.

Figure 11. The number of driving and rest time violations is 15-20 percent from year to year. (Source: Police of Finland)

It is clear that regulations on driving and rest periods and their monitoring are needed. This is emphasized by the authorities, transport interest groups and drivers. But is it modern to base the control of the rules on individual annual control weeks? Even during the pre-announced monitoring weeks, 15-20 percent of drivers violate driving and rest periods. This is seen for example in Finland every year when the control week is arranged by the police. What happens outside the control weeks? Is the current situation the best way to ensure road safety and fair competition in the transport sector? Could it be supported by new technology?

Due to the Covid-19 pandemic, many European countries introduced exemptions to driving and rest periods in the spring of 2020. The situation caused by the Covid-19 pandemic can also be seen as an exceptional experiment in driving and rest periods.

The following exceptions were in place in Sweden and Finland:

1) daily driving time may be no more than 11 hours

2) weekly driving time may be no more than 60 hours

3) driving time accumulated during two consecutive weeks may be no more than 120 hours

4) daily rest period must be at least 9 hours each day

5) weekly rest period may be shortened to at least 24 hours every other week without a compensatory rest period

6) a 5.5 hours' drive must be followed by a break of 45 minutes, which may be divided into a 30-minute break, which is to be taken first, and a 15-minute break

7) regular weekly rest periods away from base may according to the driver's choice be taken in a vehicle, as long as it has suitable sleeping facilities for each driver and the vehicle is stationary.

These exceptions that lasted more than a month did not cause any significant problems. Perhaps some of these could also be considered for use in the normal post-pandemic period.

Figure 12. Tachograph follows the driving and resting periods. The basic rule is that you need a 45-minute rest after 4,5 hours driving. (Source: Scania video)

In addition to the temporary exemptions for driving time and rest periods related to the Covid-19 pandemic, there are permanent exemptions applying to all EU Member States as well as country-specific exemptions.

Exceptions applying to all Member States

Exceptions have been enacted to the general rules provided in the European Driving Time and Rest Periods Regulation, including both exceptions that cover all Member States and exceptions that apply to specific Member States. Although the wording of many of the clauses concerning exceptions refers only to vehicles, these provisions should be interpreted as referring to the type of carriage for which each vehicle is used.

Exceptions applying to all Member States are listed in Article 3 of the Regulation, which states that the Regulation does not apply to carriage by road by:

- vehicles used for the carriage of passengers on regular services where the route covered by the service in question does not exceed 50 kilometres
- vehicles or combinations of vehicles with a maximum permissible mass not exceeding 7.5 tonnes used for carrying materials, equipment or machinery for the driver's use in the course of their work, and which are used only within a 100-km radius from the base of the undertaking and on the condition that driving the vehicle does not constitute the driver's main activity
- vehicles with a maximum authorised speed not exceeding 40 kilometres per hour
- vehicles owned or hired without a driver by the armed services, civil defence services, fire services, and forces responsible for maintaining public order when the carriage is undertaken as a consequence of the tasks assigned to these services and is under their control
- vehicles, including vehicles used in the non-commercial transport of humanitarian aid, used in emergencies or rescue operations
- specialised vehicles used for medical purposes
- specialised breakdown vehicles operating within a 100-km radius of their base
- vehicles undergoing road tests for technical development, repair or maintenance purposes, and new or rebuilt vehicles which have not yet been put into service
- vehicles or combinations of vehicles with a maximum permissible mass not exceeding 7.5 tonnes used for the non-commercial carriage of goods, and
- commercial vehicles which have a historic status according to the legislation of the Member State in which they are being driven and which are used for the non-commercial carriage of passengers or goods.

Figure 13. Driving time and rest periods exemptions applying to all European Union Member States

(Source:https://www.tyosuojelu.fi/web/en/employment-relationship/driving-times-rest-periods/exceptions)

Below is an example of Finland's country-specific exceptions to driving time and resting periods. Finland intends to make changes to the country-specific exceptions during the spring of 2021: it is planned to add ready-mixed concrete drivers to the exceptions concerning driving time and rest periods.

Exceptions specific to Finland

In addition to the exceptions listed above that apply across the EU, Member States are allowed to exclude certain types of carriage from the scope of the Driving Time and Rest Periods Regulation (and thus also the Tachograph Regulation).

The Driving Time and Rest Periods Regulation does not apply to, nor does a tachograph need to be used in, the following types of carriage in Finland:

- vehicles used or hired, without a driver, by agricultural, horticultural, farming or fishery undertakings within a radius of up to 100 kilometres from the base of the undertaking on the condition that driving the vehicle does not constitute the driver's main activity and that the vehicle carries minor quantities of the undertaking's own produce which is sold at a marketplace or at another specific location, or horses kept by these undertakings
- vehicles or combinations of vehicles with a maximum permissible mass not exceeding 7.5 tonnes used for postal delivery as referred to in the Finnish Postal Act (415/2011) or for carrying materials, equipment or machinery for the driver's use in the course of their work, on the condition that the vehicle or combination of vehicles is used only within a 100-kilometre radius from the base of the undertaking and driving the vehicle does not constitute the driver's main activity
- vehicles used exclusively on an island not exceeding 2,300 square kilometres in area which is not linked to the mainland by a bridge, ford or tunnel open for use by motor vehicles
- vehicles used for driving instruction and examination with a view to obtaining a driving licence or a certificate of professional competence, provided that they are not being used for commercial transport
- vehicles used in connection with sewerage, flood protection, water, gas and electricity maintenance services, road maintenance and control, door-to-door household refuse collection and disposal, telegraph and telephone services, radio and television broadcasting, and the detection of radio or television transmitters or receivers
- vehicles with between 10 and 17 seats not used for commercial transport
- vehicles used as an educational facility when stationary
- vehicles intended for milk collection from farms and for the return to farms of milk containers or milk products intended for animal feed
- veicles transporting money or valuables
- vehicles used for carrying animal waste or carcasses which are not intended for human consumption
- vehicles used exclusively on roads inside hub facilities such as ports, interports and railway terminals
- vehicles used for the carriage of live animals from farms to local markets or to slaughterhouses and vice versa, within a radius of up to 100 kilometres from the farm, and
- specialised vehicles of a circus or funfair.

Figure 14. Driving time and rest periods exemptions specific to Finland

(Source:https://www.tyosuojelu.fi/web/en/employment-relationship/driving-times-rest-periods/exceptions)

5.1.1. Conclusions on smart and flexible driving and resting times for the smart last mile

As described on the previous pages, driving time and rest period rules have been granted many exceptions and for various reasons.

Would the time be ripe for a cause based on climate goals?

COMBINE WP 4.2 suggests:

1. The competitiveness of the whole combined transport chain could be improved by granting exemptions from the driving time and rest periods for last mile road transport;

2. Exceptions to driving times and rest periods could be in line with those applied during the Covid-19 pandemic;

3. Traffic safety would be supported by requiring the use of advanced driver-assistance systems (ADAS) such as platooning as a support function (ACC, CACC) - in the spirit of the EU Mobility Package:
   „Rapid technological progress is resulting in the gradual automation of driving systems which require less or no direct input from the driver. To address those changes, current legislation, including rules on driving and resting times, may need to be adapted in order to guarantee road safety and a level playing field and to improve working conditions, whilst enabling the Union to pioneer new innovative technologies and practices. Therefore, the Commission should submit a report evaluating the use of autonomous driving systems in the Member States, including the benefits of autonomous driving technologies. That report should be accompanied, if appropriate, by a legislative proposal.“

   (Source: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2020:249:FULL)

4. Exceptions to driving and rest times would be conditional on a commitment to speed limits, which would reduce speeds in practice from 85 km/h to 80 km/h, save fuel and reduce CO2 emissions by 5%;

5. Compliance with the granted exceptional driving and rest times and compliance with the maximum speed of 80 km/h would be monitored by means of modern fleet management systems.

Effective last mile road transport measures that have been shown to improve the competitiveness of the entire combined transport chain have already been put in place in Europe. One of these is a kind of driving time exemption:

- *Exemptions from the driving ban on weekends and bank holidays and from the holiday driving ban.*

Smart and flexible driving and resting times for the last mile of combined transport would be a logical continuum to this.

5.2 Digital control of smart last mile

Possible flexibilities regarding driving and rest times are a sensitive issue. This certainly raises a lot of questions about road safety, drivers' rights and the competitive situation between companies. If the driving and rest times already in force are generally violated, will the situation worsen if driving times and rest periods are given flexibility? How to ensure that the conditions for driving time and rest periods exemptions are met? The concern is justified.

Modern fleet management systems offer an opportunity for last mile digitization. The following is an example of how the Volvo Connect system, launched in early 2021, can support digitalization and control of the smart last mile. Volvo Connect and other similar systems monitor for example vehicle location, speed, weight, driving safety as well as driving times and rest periods in real time. The system can be harnessed to support the smart last mile and report any events exceeding the approved exceptions concerning the smart last mile.

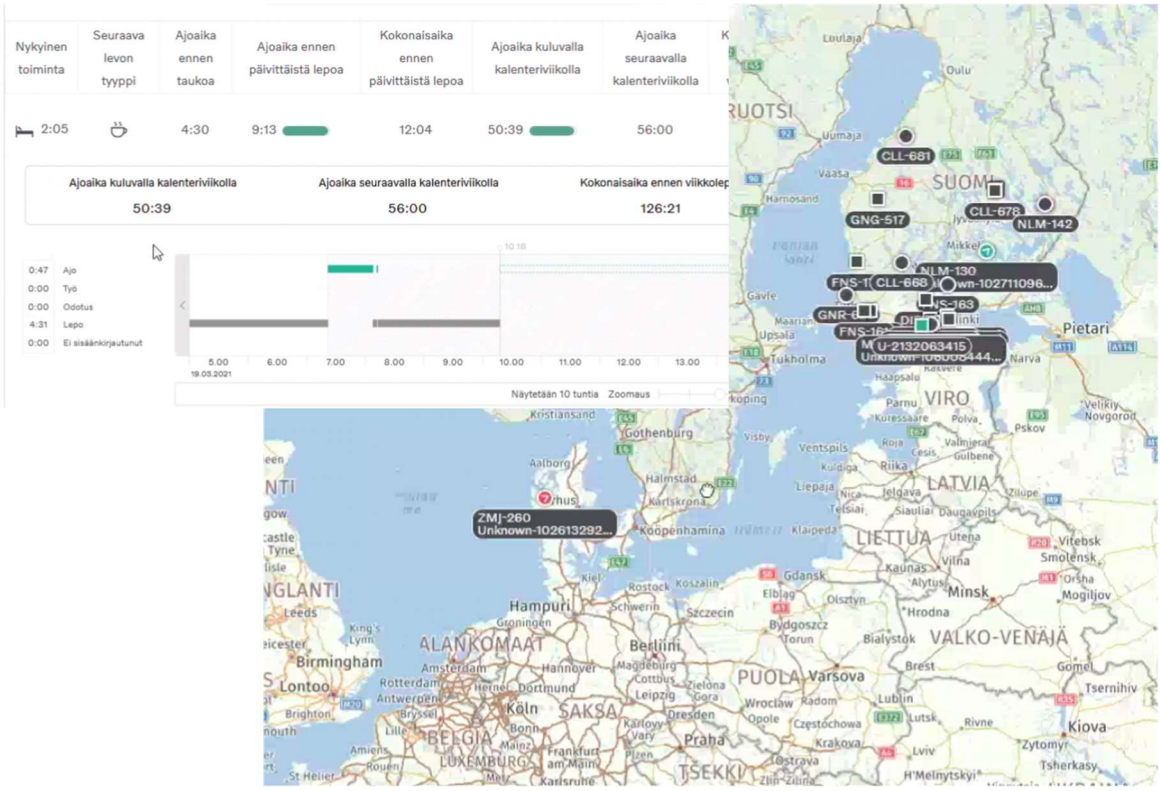


Figure 15. Volvo Connect Fleet management system was launched early 2021. It can be used for example all around Europe and in local languages.

5.2.1 Geofencing

Smart last mile exemptions (such as flexible driving times and rest periods or longer and heavier combinations) that increase the competitiveness of the whole combined transport chain would only apply in a geographically limited area. Vehicles that have been granted smart last mile exemptions should remain within the defined geographical area.

Geofencing can be used to control this. Geofencing is a virtual fence that controls vehicles' movements within a geographical area. Volvo Connect - and other modern fleet management systems - offer geofencing opportunities.

Geofence can be defined following ways:

- a specific route, in which case a deviation of a specified size (100, 500, 1000, 1500 meters) will cause an alarm (Figure 16)
- freely defined area delimitation; area shape and size can be freely defined (Figure 17)
- border of a country

If a geofence controlled vehicle violates a defined geofence rule (exits the route, arrives or departs from the specified area), the system notifies the deviation by sending an e-mail to the given address - even to the supervisory authority.

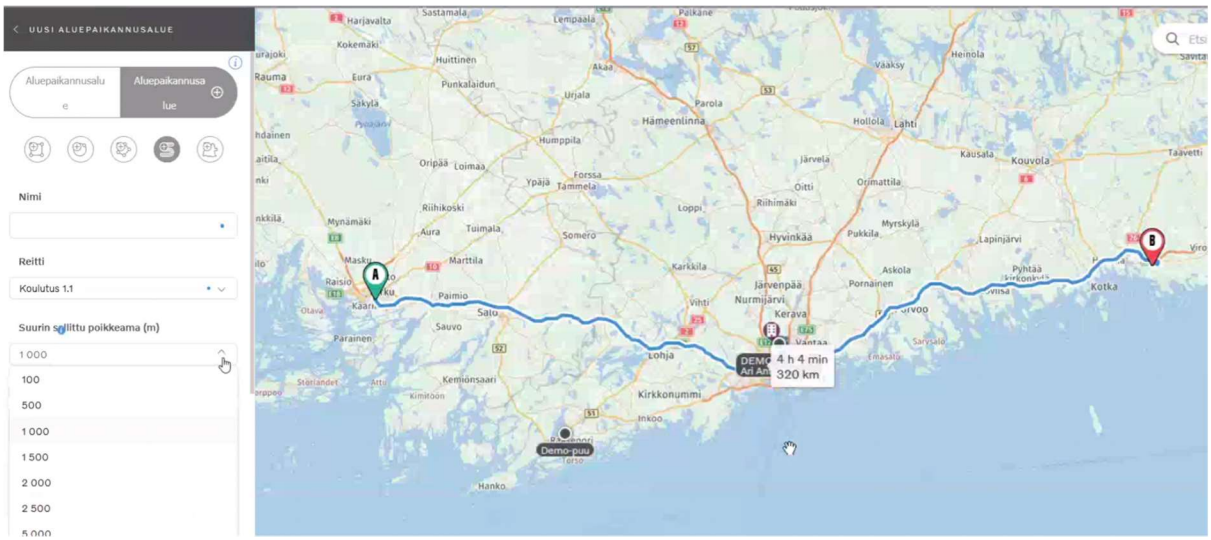


Figure 16. Geofencing offered by modern fleet management systems can be used to ensure that combinations benefiting from exemptions remain on their assigned routes. (Picture: Volvo Connect system)

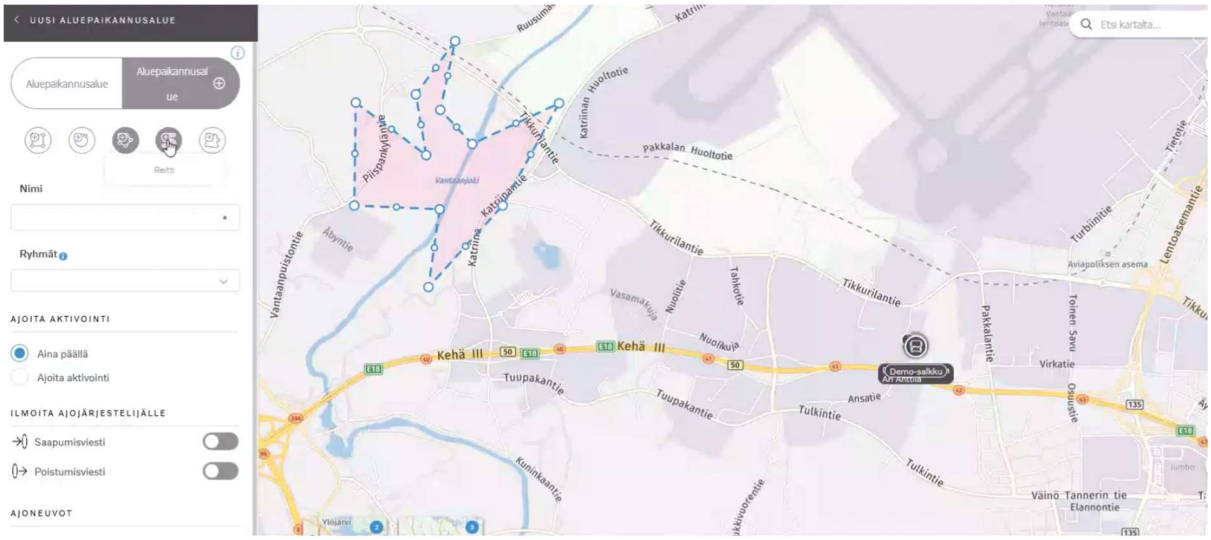


Figure 17. In a freely definable geofencing area, last mile exceptions may be allowed, for example in the hinterland area of a combined transport terminal. (Picture: Volvo Connect)

Australia has long used geofencing – Intelligent Access Program (IAP) - to control that longer and heavier combinations remain on the specified route. According to the Australian authorities, “the IAP provides a 21st century solution to ensure ‘the right truck is on the right road at the right time’”.

Australia is an inspiring example of the production use of smart last mile solutions: it is not just about technology; the roles of different authorities and Intelligent Access Program processes are also essential. Australian experiences and best practices can be learned as European and Baltic Sea Regions begin to apply smart last mile practices.

5.2.2 Speed control

Exceptions to driving and rest times would be conditional on a commitment to speed limits, which would reduce speeds in practice from 85 km/h to 80 km/h, save fuel and reduce CO2 emissions by 5%. Compliance with the exceptional driving and rest times granted and compliance with the maximum speed of 80 km/h would be monitored by means of modern fleet management systems.

Modern Fleet management systems can monitor the speed of combinations in real time. For example, if the speed exceeds 80 km/h for ten minutes, the system notifies the deviation by sending an e-mail to the given address - even to the supervisory authority. Thus, systematic speeding can be addressed, not momentary overshoots.

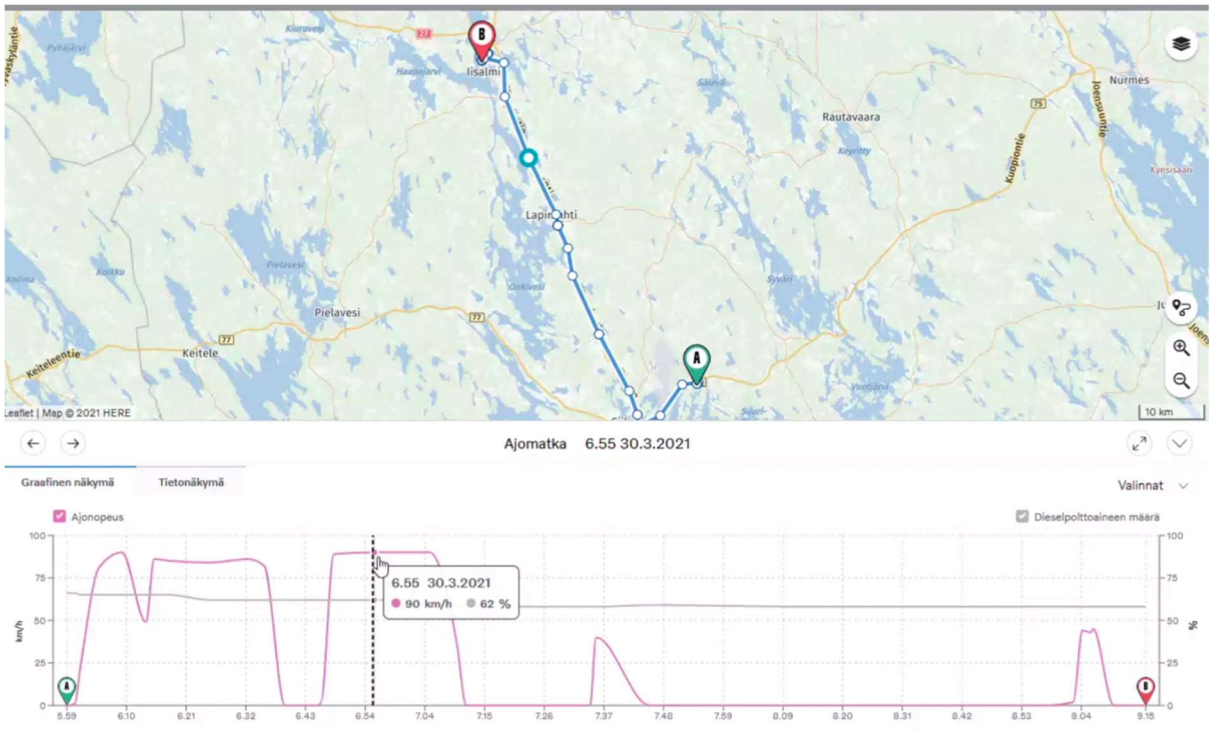


Figure 18. Modern fleet management systems can monitor vehicle speeds in real time and address speeding. (Picture: Volvo Connect)

5.2.3 Safety

Safe driving can be monitored extensively. The fleet management system generates notifications of possible severe braking and emergency braking, as well as activations of safety systems related to vehicle stability (for example ESC). The fleet management system identifies anomalous situations and sends a notification to the desired email. Commitment to safe driving can be made a condition for exceptions to driving and rest times.

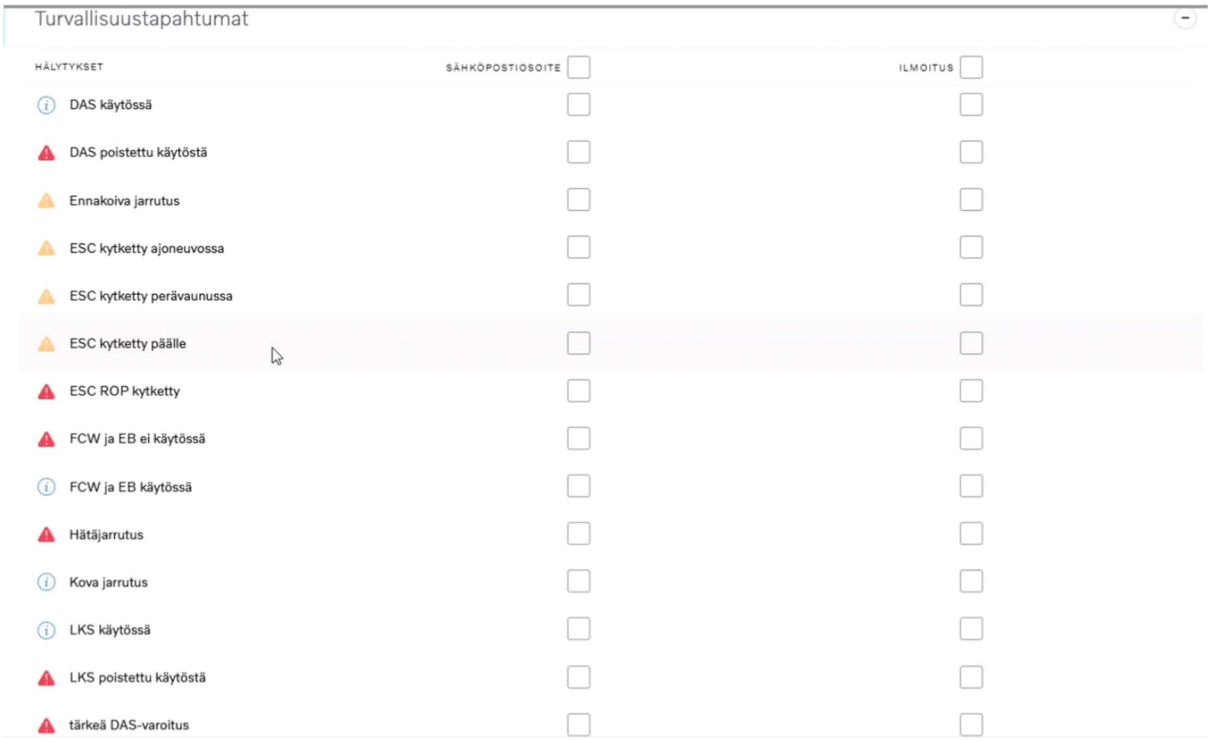


Figure 19. Traffic safety-related events, such as emergency braking, can be monitored with the fleet management system. (Picture: Volvo Connect)

5.2.4 Systems independent of vehicle manufacturers

Smart last mile control can also be built into systems independent of vehicle manufacturers. One possibility is to take advantage of the systems used by the Australian Intelligent Access Program (IAP). Smart last mile control can also provide opportunities for start-up companies. Below is an example of a system developed by the Finnish company Millisecond Ltd, which can be used to read the vehicle's information system via the CAN bus and produce information on the mass of combinations, for example.

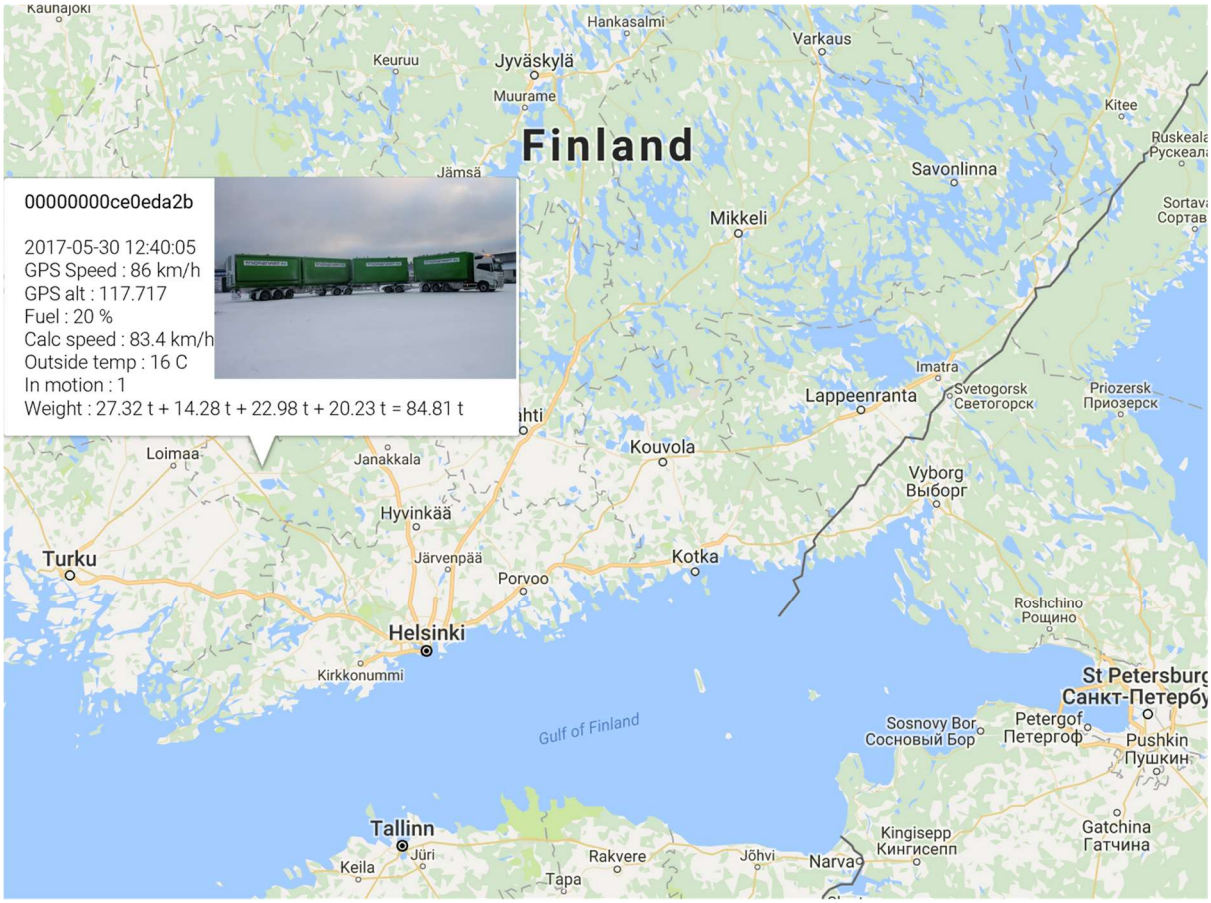


Figure 20. Fleet management systems independent of vehicle manufacturers are also available. (Picture: Millisecond)

5.2.5 Conclusions on digital control of smart last mile

As described on previous pages, digital control of smart last mile allows control of the exceptions proposed by COMBINE WP 4.2.

1. the competitiveness of the whole combined transport chain could be improved by granting exemptions from the driving time and rest periods for last mile road transport;

2. exceptions to driving times and rest periods could be in line with those applied during the Covid-19 pandemic;

3. traffic safety would be supported by requiring the use of advanced driver-assistance systems (ADAS) such as platooning as a support function (ACC, CACC) - in the spirit of the EU Mobility Package:

   „Rapid technological progress is resulting in the gradual automation of driving systems which require less or no direct input from the driver. To address those changes, current legislation, including rules on driving and resting times, may need to be adapted in order to guarantee road safety and a level playing field and to improve working conditions, whilst enabling the Union to pioneer new innovative technologies and practices. Therefore, the Commission should submit a report evaluating the use of autonomous driving systems in the Member States, including the benefits of autonomous driving technologies. That report should be accompanied, if appropriate, by a legislative proposal.“

   Source: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2020:249:FULL

4. exceptions to driving and rest times would be conditional on a commitment to speed limits, which would reduce speeds in practice from 85 km / h to 80 km / h, save fuel and reduce CO2 emissions by 5%;

5. compliance with the exceptional driving and rest times granted and compliance with the maximum speed of 80 km / h would be monitored by means of modern fleet management systems.

Monitoring can be carried out using modern, commercially available fleet management systems or systems specifically developed for the use of public authorities.

5.3 Infrastructure analysis

Platooning has following infrastructure demands:

- high-quality motorway with at least two lanes in both directions to facilitate bypassing
- readability of the road environment i.e. quality of road markings - line width and retro-reflectivity - is essential
- 4G / 5G network for communication between fleet management systems and vehicles - vehicle to vehicle communication (V2V) does not need 4G / 5G
- vertical geometry of the road is an advantage if the road section does not have large hills
- adequate transport volume, road connection part of the combined transport last mile leg
- a sufficient number of hubs (terminals, heavy traffic resting areas) in which platoons are formed

Figure 21. The infrastructure of the Tampere-Helsinki highway was carefully analysed from a platooning perspective. (Picture: Ramboll)

Helsinki - Tampere highway connects Finland's largest regions: The Helsinki-Uusimaa Region (1.7 million inhabitants) and the Tampere region (520,703 inhabitants). In addition, the highway connects to international combined transport chains via the Port of Helsinki.

The road connection is four-lane all the way and 180 km long. The road profile does not include large hills, the height difference is 140 meters.

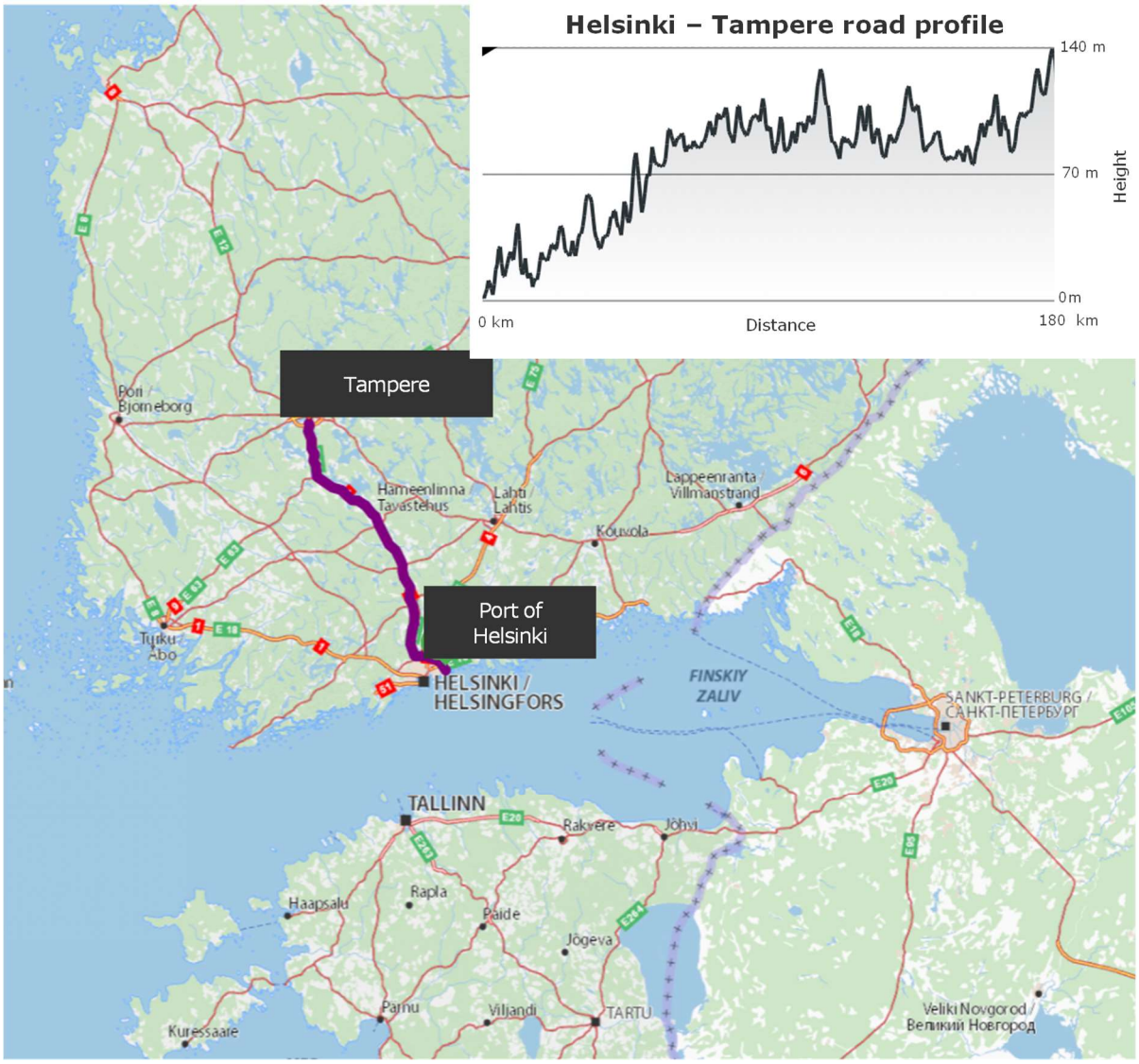


Figure 22. Helsinki – Tampere highway geometry. (Source: Ramboll)

The Helsinki-Tampere Highway is one of the highest quality routes in Finland. The road is in the highest maintenance class and the condition of the road is monitored with regular and varied measurements. The readability of the road environment i.e. quality of road markings - line width and retro-reflectivity - is essential for advanced driver-assistance systems (ADAS) such as platooning as a support function (ACC, CACC).

The European Union Road Association (ERF) has presented a proposal on the functional characteristics of road markings and the width of longitudinal line markings for their maintenance. According to the presentation, the width of the longitudinal line markings must be at least 15 cm.

Helsinki - Tampere highway exceeds the recommendation of the European Union Road Association (ERF) - the width of the lines is 20 cm. Readability of the road environment i.e. quality of road markings is measured every spring. If the measurement shows that more than 30 per cent of the line has passed, i.e. less than 70 per cent of the 20 cm wide line remains (70% x 20 cm = 14 cm), treatment measures are initiated. Therefore, the ERF recommendation is also fulfilled when the lines are worn.

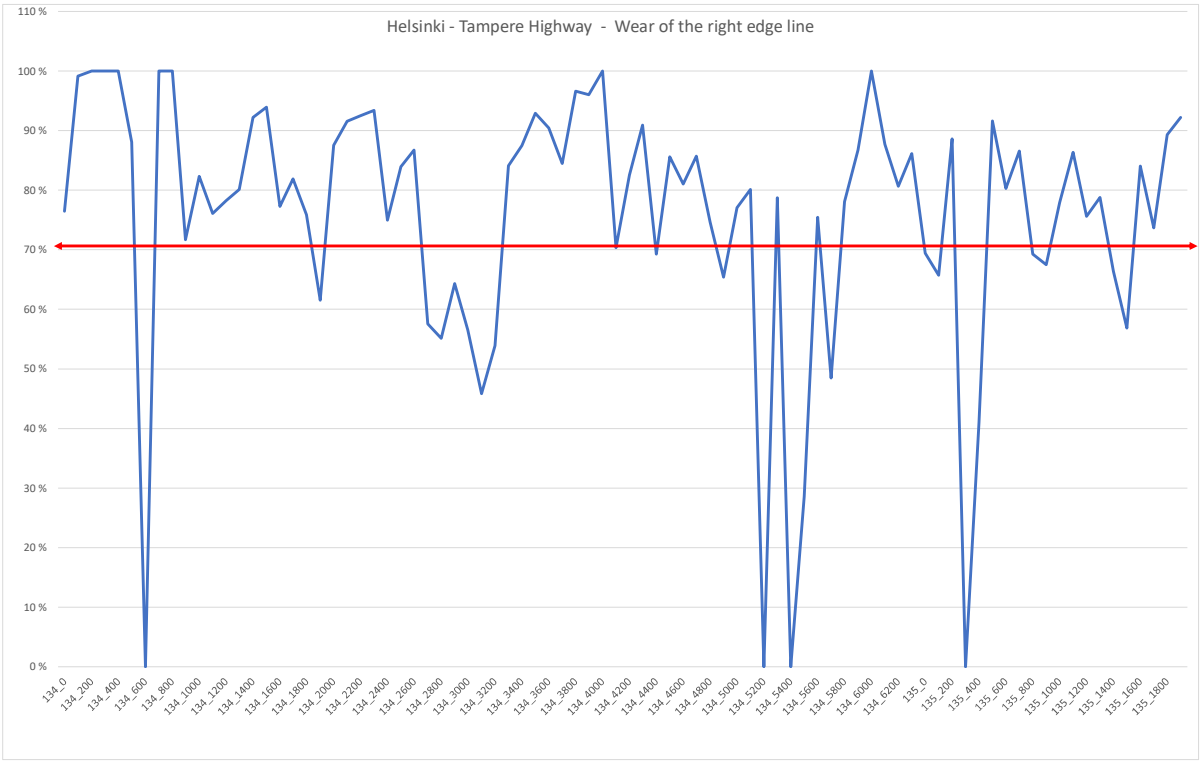


Figure 23. Helsinki - Tampere Highway - Wear of the right edge line. (Source: Ramboll)

Retro-reflectivity of road markings is also measured on regular basis:

- The value describes the amount of light reflected from the car's lights in a certain geometry
- Tells how well the marking is visible in dark and dry weather
- Measured in spring / early summer before labelling maintenance
- The action limit is 100 mcd -> all periods below that number will be maintained.

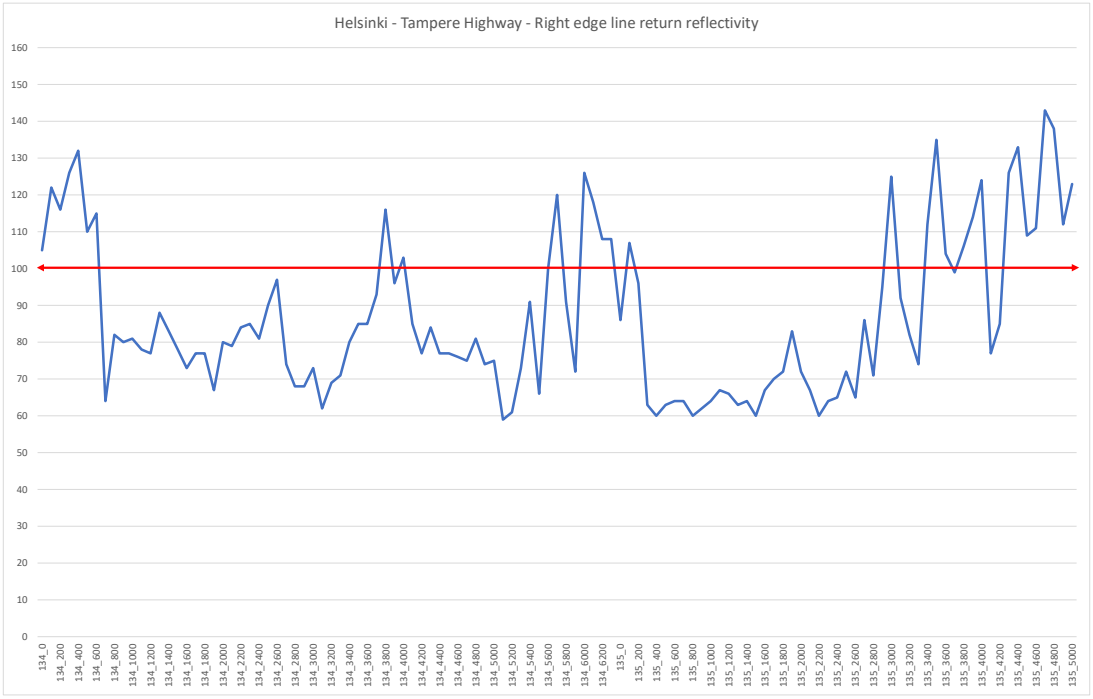


Figure 24. Helsinki – Tampere Highway, Right edge line return reflectivity. (Source: Ramboll)

The international roughness index (IRI) is also regularly measured from Helsinki Tampere highway. On a high-class motorway with a speed limit of 120 km / h, the IRI value should be less than 1.8.

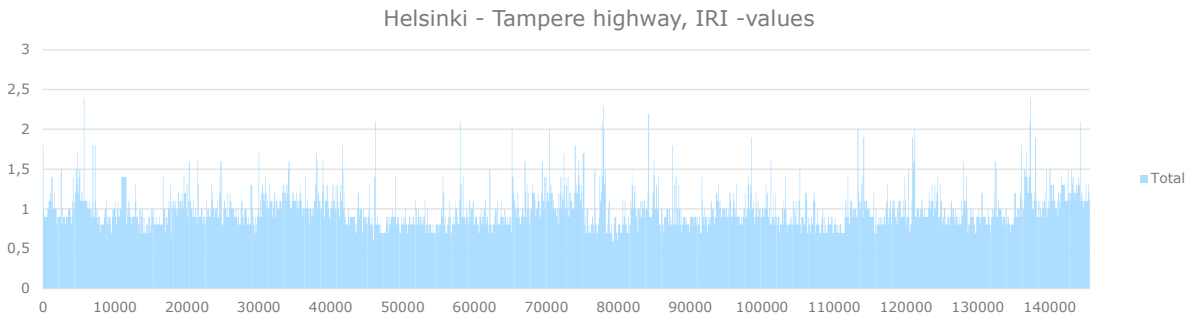


Figure 25. Helsinki – Tampere Highway IRI-values. (Source: Ramboll)

In terms of platooning, one of the most important things in the Tampere - Helsinki Highway road infrastructure is the hubs of heavy traffic - especially the Port of Helsinki and heavy traffic rest areas. The arrival and departure of container and ro-ro ships also pace the last mile of road transport and likewise affect driving time and rest periods regulations for daily rest. Convoys with typically two to four vehicle combinations are already bursting from the heavy traffic hubs on the Tampere - Helsinki highway. Convoys, platoons, are an already occurring phenomenon. It is essential to consider how their environmental friendliness, safety and drivers' working conditions can be improved.

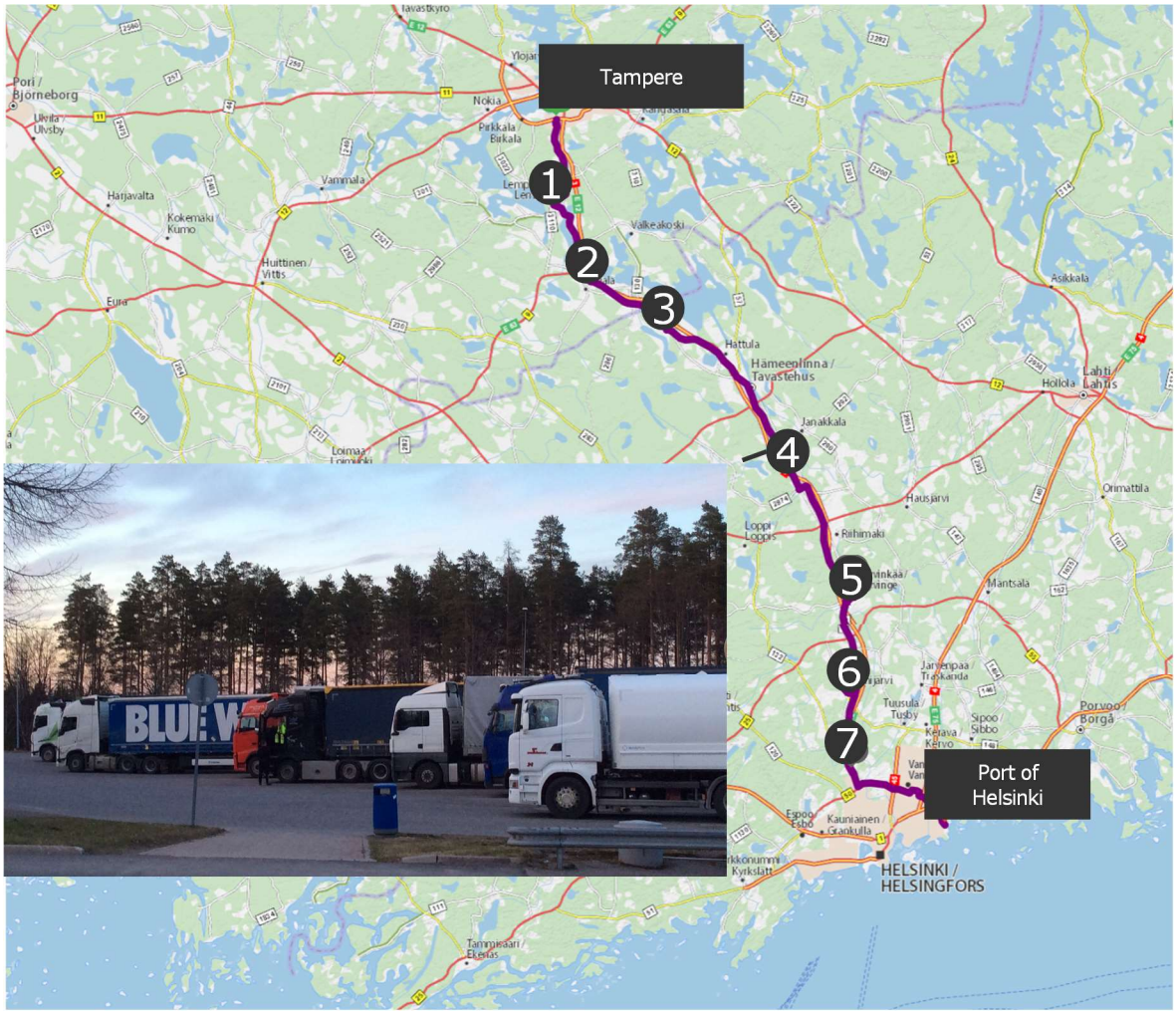


Figure 26. The Helsinki-Tampere highway has several heavy traffic hubs (Port of Helsinki, heavy traffic rest areas) which, due to their logistical nature, produce convoys with two to four combinations. Reducing emissions from these existing convoys is an integral part of the development of a responsible last mile leg. Properly applied, platooning as a support function makes this possible. (Source: Ramboll)

5.4 Needed adaptations to make Tampere-Helsinki highway ready for platooning

At the start of the COMBINE project, platooning was expected to require a 5G network for vehicle-to-vehicle communication and significant intelligence from road infrastructures as well. This was expected to lead to infrastructure-related changes and investment needs. That did not happen. Expectations have become more precise, platooning has following infrastructure demands:

- high-quality motorway with at least two lanes in both directions to facilitate bypassing
- readability of the road environment i.e. quality of road markings - line width and retro-reflectivity - is essential
- 4G / 5G network for communication between fleet management systems and vehicles - vehicle to vehicle communication (V2V) does not need 4G / 5G
- vertical geometry of the road is an advantage if the road section does not have large hills
- adequate transport volume, road connection part of the combined transport last mile leg
- a sufficient number of hubs (terminals, heavy traffic resting areas) in which platoons are formed

As stated in the previous paragraphs, the Tampere - Helsinki Highway meets the platooning infrastructure requirements quite well. Platooning does not require new investments, of course, for example, the maintenance of road markings and IRI targets requires maintenance investments. This significantly simplifies the introduction of platooning for infrastructure authorities - normal road maintenance, the existing maintenance budget, the division of responsibilities between authorities and the risk management procedures already in place are sufficient.

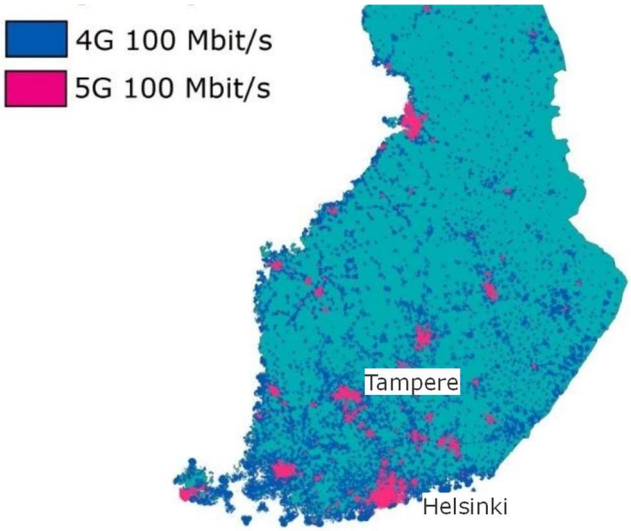


Figure 27. The 5G network is becoming more common in cities, but it will still take time to get 5G coverage of interurban highways. The introduction of platooning is greatly facilitated by the fact that a 5G network is not required. (Source: Traficom)

6 MARKET ANALYSIS

Expectations for platooning have fluctuated in recent years, but perhaps the average market expectation can be considered 5% fuel savings per combination. On a European scale, the market analysis outlined the Companion project assuming a 5% fuel reduction per combination - nearly 1 billion liters of fuel per year could be saved, not to mention the corresponding reduction in CO2 emissions. The potential of the platooning market is significant not only economically but also from an environmental perspective.

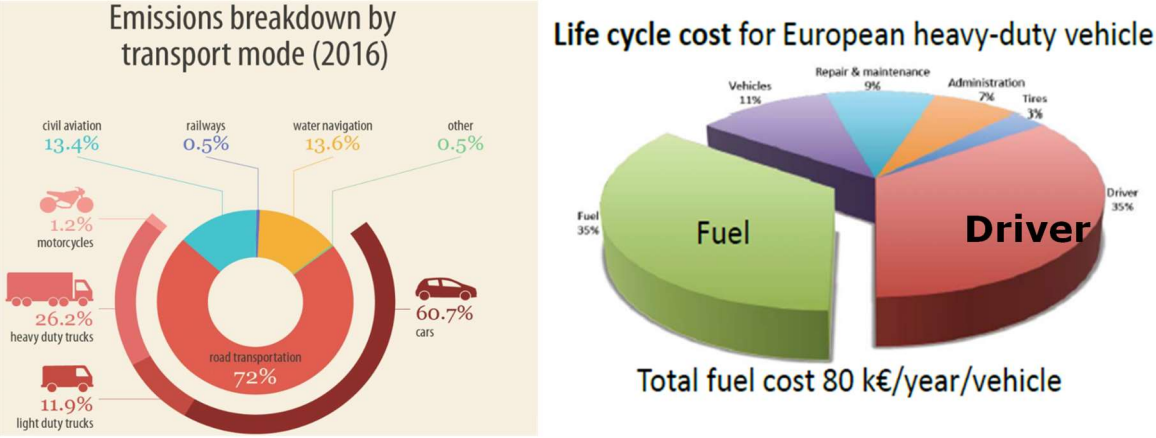


Figure 28. The market need is obvious from both an environmental and an economic point of view. (Sources: European Environment Agency and Scania)

The Tampere Helsinki highway heavy traffic is about 97,000,000 kilometers a year and the fuel consumption is estimated at 34 million liters a year. A 5% saving on this is 1,700,000 liters. Fuel costs are a very significant part of the cost of heavy transport - it is important not only for the environment, but also for the economy of transport companies.

The main platooning customer base and users would consist of combined transport first / last mile shipments (Finnish export and import commodities), which could be complemented by domestic transport combinations and commodities if necessary. Annual volume is approximately half million vehicle combinations.

7 RECOMMENDATIONS

As described in the previous sections, COMBINE WP 4.2 has developed a business model based on platooning as a support function which can streamline the last mile of combined transport and thus the entire combined transport chain.

1. the competitiveness of the whole combined transport chain could be improved by granting exemptions from the driving time and rest periods for last mile road transport;

2. exceptions to driving times and rest periods could be in line with those applied during the Covid-19 pandemic;

3. traffic safety would be supported by requiring the use of advanced driver-assistance systems (ADAS) such as platooning as a support function (ACC, CACC) - in the spirit of the EU Mobility Package:

   „Rapid technological progress is resulting in the gradual automation of driving systems which require less or no direct input from the driver. To address those changes, current legislation, including rules on driving and resting times, may need to be adapted in order to guarantee road safety and a level playing field and to improve working conditions, whilst enabling the Union to pioneer new innovative technologies and practices. Therefore, the Commission should submit a report evaluating the use of autonomous driving systems in the Member States, including the benefits of autonomous driving technologies. That report should be accompanied, if appropriate, by a legislative proposal.“

   Source: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2020:249:FULL

4. exceptions to driving and rest times would be conditional on a commitment to speed limits, which would reduce speeds in practice from 85 km / h to 80 km / h, save fuel and reduce CO2 emissions by 5%;

5. compliance with the exceptional driving and rest times granted and compliance with the maximum speed of 80 km / h would be monitored by means of modern fleet management systems.

The proposal is feasible in many respects:

- based on existing technology: platooning as a support function (ACC, CACC) and modern fleet management systems
- is in line with the spirit of the European Union's mobility package
- is an inherent continuation of the last mile driving time exemptions for combined transport already in force: *Exemptions from the driving ban on weekends and bank holidays and from the holiday driving ban.*
- meets key expectations for platooning technology, drops fuel consumption and CO2 emissions by 5% and brings flexibility to driver driving and rest time

Convoys, platoons serving the last mile of combined transport chain are an already occurring phenomenon. It is essential to consider how their efficiency, environmental friendliness, safety, and drivers' working conditions can be improved. It has an impact on the competitiveness of the entire combined transport chain.

Figure 29. Convoys, platoons with two to four combinations are a common sight on the Helsinki Tampere Highway. (Photo credit: Ramboll)

COMBINE WP 4.2 recommends:

1. Field test of the proposal: platooning as a support function, flexible driving times and resting periods and commitment to 80 km / h speed limit. The field test shall:
    - be run under close observation from the authorities
    - use an exemption from the drive and rest times
    - use the tachograph to pinpoint where changes could be beneficial
    - not give obvious advantages toward other hauliers
    - stopped if misused or procedures are not obeyed
    - held on a high-end, supervised 4-lane highway

2. Further research on digital control of the smart last mile: digital control of the smart last mile enabled by modern fleet management systems may allow, for example, the controlled use of HCT combinations on certain combined transport last mile routes.

3. Further studies on speed reduction: 80 km / h and flexibility in driving and rest times can open up opportunities in the same direction as ships' slow steaming. Engines - power and size - are likely to be reduced, and emission reductions are expected, as ships' slow steaming experience shows. Opportunities to use LNG and electric motors are likely to increase.

8 FIELD TEST IMPLEMENTATION

7.1 Lessons learned from the Finnish HCT pilot program

When planning a field test - platooning as a support function, flexible driving times and resting periods and commitment to 80 km / h speed limit implementation, a model could be taken from the HCT combination pilot program implemented in Finland in 2013–2018. The pilot program for HCT combinations was a success, culminating in the enactment of laws allowing the production use of HCT combinations in January 2019.

The Finnish authorities created a legal framework to enable the pilot program, granted and monitored the exemptions applied for by companies. The development work of HCT combinations and the 13 million test kilometres driven took place entirely with the companies' own funding without public support. Society persuaded companies to carry out development work and achieve the European Union's climate goals in a significant way.

The crucial thing is to allow experimentation as part of one's business. Based on the experience of the HCT program, it can be said that companies are interested in developing and trying new solutions when they are allowed to do so as part of their day-to-day business. If one thinks concretely about 13 million test kilometres driven, no one can afford to drive it outside their own business - and it wouldn't even make sense environmentally.

Exemptions must, of course, be made carefully, competition between companies must not be distorted by exemptions, drivers' working conditions must not be impaired and road safety must not be jeopardized.

The HCT pilot program succeeded in all of this. How?

- The Finnish Ministry of Transport and Communications added a right to the legislation, on the basis of which the safety agency Traficom was granted the right to launch a research program on HCT combinations.
- National safety agency Traficom launched the HCT pilot program, set up a steering group to deal with all exemption applications while ensuring that the exemption did not jeopardize the transport market or road safety.
- This really became a necessity, with more than 40 companies participating, developing, and testing HCT combinations in their own day-to-day operations and with their own funding, driving more than 13 million test kilometres.

Something similar would also be needed in a field test - platooning as a support function, flexible driving times and resting periods and commitment to 80 km / h speed limit. Allowing testing and development in production use - of course, closely monitoring that the competitive situation in the transport market is not jeopardized, working conditions for drivers impaired or road safety impaired – could lead to a significant contribution from companies, without financial support from society.

7.2 Legal view

The rule of law must be implemented in all activities in the European Union, it is a fundamental value. Driving and rest time legislation is European, not national. At the same time, the European Union's Mobility Package calls for preparation for an advanced driving support system - such as platooning - and the legislative changes they will bring, including driving and rest time. COMBINE WP 4.2 proposes that existing exceptions to driving and rest time - exceptions applying all member states - and in particular the section "vehicles undergoing road test for technical development" underlined below in red, should be interpreted as meaning that platooning as a support function, flexible driving times and resting periods and commitment to 80 km / h speed limit could be tested in a controlled manner in the production use of companies - in the same way as the Finnish HCT test program was implemented.

This interpretation by the European Union would make it possible to launch limited and controlled national pilot programs and would certainly contribute to the objectives set out in the European Union's mobility package.

Exceptions applying to all Member States

Exceptions have been enacted to the general rules provided in the European Driving Time and Rest Periods Regulation, including both exceptions that cover all Member States and exceptions that apply to specific Member States. Although the wording of many of the clauses concerning exceptions refers only to vehicles, these provisions should be interpreted as referring to the type of carriage for which each vehicle is used.

Exceptions applying to all Member States are listed in Article 3 of the Regulation, which states that the Regulation does not apply to carriage by road by:

- vehicles used for the carriage of passengers on regular services where the route covered by the service in question does not exceed 50 kilometres
- vehicles or combinations of vehicles with a maximum permissible mass not exceeding 7.5 tonnes used for carrying materials, equipment or machinery for the driver's use in the course of their work, and which are used only within a 100-km radius from the base of the undertaking and on the condition that driving the vehicle does not constitute the driver's main activity
- vehicles with a maximum authorised speed not exceeding 40 kilometres per hour
- vehicles owned or hired without a driver by the armed services, civil defence services, fire services, and forces responsible for maintaining public order when the carriage is undertaken as a consequence of the tasks assigned to these services and is under their control
- vehicles, including vehicles used in the non-commercial transport of humanitarian aid, used in emergencies or rescue operations
- specialised vehicles used for medical purposes
- specialised breakdown vehicles operating within a 100-km radius of their base
- vehicles undergoing road tests for technical development, repair or maintenance purposes, and new or rebuilt vehicles which have not yet been put into service
- vehicles or combinations of vehicles with a maximum permissible mass not exceeding 7.5 tonnes used for the non-commercial carriage of goods, and
- commercial vehicles which have a historic status according to the legislation of the Member State in which they are being driven and which are used for the non-commercial carriage of passengers or goods.

7.3. Field test authorities

The reference in the European Union's Mobility Package to advanced driving systems and drive and rest time issues is quite recent and is not yet actively on the authorities' agenda. COMBINE WP 4.2 has tentatively outlined the possibilities of applying the experiences of the Finnish HCT program to this theme. COMBINE WP 4.2 hopes that the following authorities will consider participating in or contributing to the implementation of the field test (platooning as a support function, flexible driving times and resting periods and commitment to 80 km / h speed limit).

- European Commission, DG MOVE, Road Transport Unit
  - to consider if, exceptions to driving and rest time - exceptions applying all member states - and in particular the section "vehicles undergoing road test for technical development", could be interpreted as meaning that platooning as a support function, flexible driving times and resting periods and commitment to 80 km / h speed limit could be tested in a controlled manner in the production use of companies - in the same way as the Finnish HCT test program was implemented.

- National transport ministries
  - Assuming a positive position from DG MOVE, the national ministry of transport should consider a legislative change that would allow the national road safety agency to launch a pilot program on driving and rest times - similar to the implementation of the Finnish HCT pilot program.

- National road safety agency
  - Implement a pilot program on driving and rest times, set up a management team, open an application procedure for companies to apply for exemptions, evaluate applications and select a few dozen pilots for implementation.

A similar procedure gave good results with regard to the introduction of HCT combinations in Finland. The implementation motivated both authorities and companies. A similar procedure should be considered for autonomous driving systems and flexibility in driving and rest periods.

The results are also likely to benefit the European Commission, which, according to the European Union's Mobility Package, should address the issue by 2025: "*The Commission should submit a report evaluating the use of Autonomous driving technologies in the Member States, including the benefits of Autonomous driving technologies. That report should be accompanied, if appropriate, by a legislative proposal.*" *(Source: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2020:249:FULL)*