



# ENSEMBLE

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### ENSEMBLE

ENabling SafE Multi-Brand pLatooning for Europe

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## EXECUTIVE SUMMARY

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### 1.2. CONTEXT AND NEED OF A MULTI BRAND PLATOONING PROJECT

#### *Context*

Platooning technology has made significant advances in the last decade, but to achieve the next step towards deployment of truck platooning, an integral multi-brand approach is required. Aiming for Europe-wide deployment of platooning, ‘multi-brand’ solutions are paramount. It is the ambition of ENSEMBLE to realise pre-standards for interoperability between trucks, platoons and logistics solution providers, to speed up actual market pick-up of (sub)system development and implementation and to enable harmonisation of legal frameworks in the member states.

#### *Project scope*

The main goal of the ENSEMBLE project is to pave the way for the adoption of multi-brand truck platooning in Europe to improve fuel economy, traffic safety and throughput. This will be demonstrated by driving up to seven differently branded trucks in one (or more) platoon(s) under real world traffic conditions across national borders. During the years, the project goals are:

- Year 1: setting the specifications and developing a reference design with acceptance criteria
- Year 2: implementing this reference design on the OEM own trucks as well as perform impact assessments with several criteria
- Year 3: focus on testing the multi-brand platoons on test tracks and international public roads

The technical results will be evaluated against the initial requirements. Also, the impact on fuel consumption, drivers and other road users will be established. In the end, all activities within the project aim to accelerate the deployment of multi-brand truck platooning in Europe.

#### *Abstract of this Deliverable*

This deliverable analyses the current state of the European regulation on Truck Platooning, which is part of the Task 6.3 Regulatory framework evolution for platooning. Part of this work consists in reviewing the background information available from previous or current projects related to platooning, in order not to repeat work and set a starting point for ENSEMBLE project.

Firstly, this document reviews the background information from other relevant projects and initiatives. The main projects that have played an important role in the platooning era are: COMPANION (Cooperative dynamic formation of platoons for safe and energy-optimized goods transportation) and CARTRE (Coordination of Automated Road Transport Deployment for Europe).

Both projects have brought relevant conclusions for the development and deployment of platoons in Europe. COMPANION has set the basic know-how and technology of platoons through a “one brand” platooning demonstration and CARTRE has analysed the needs at short and long term in order to enable the deployment of highly automated vehicles.

Another relevant initiative for the promotion of platooning is the ETPC European Truck Platooning Challenge 2016. Thanks to their cross-border platooning experiment, several lessons have been summarized [16] and learned. Their results and conclusions are also exposed in this report and will be considered for the correct development of the project.

Secondly, this deliverable provides a description of the structure of the regulatory bodies (mainly UNECE and EC) and its main players, the discussion groups. An important step before talking about regulations is to understand who the stakeholders are and how the rule-making works at an international level. It has to be taken into account that at the end of the project, recommendations to the regulatory framework will have to be given in order to allow platoons to become a reality.

In addition, a regulatory matrix is presented and commented in order to understand the current state of the art of the regulatory framework regarding platooning. In this matrix, regulations and directives are analysed from the vehicle, use and infrastructure point of view so as to path the way to identify the possible gaps regulations have in order to give recommendations to the future regulatory framework for platooning. The objective is to validate this matrix and its comments with all the OEMs involved in the project in order to align opinions and regulatory knowledge. In addition, important topics under discussion are reviewed and discussed in order to detect and predict how the regulation is going to evolve in parallel to the development of the project.

Finally, there are several topics that are being discussed nowadays in the UNECE WP29 sessions. These topics prove to be very relevant for the project development. Examples of these topics under discussion are the new series of amendments for UN Regulation No. 79 (which could introduce for instance category B2 systems such as the LKAS hands-off), the future testing protocol for vehicles equipped with new autonomous technologies which is being discussed at the VMAD Working Group or the forthcoming regulations for Cyber Security, Over-The-Air updates or Software Identification Number.



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## 2. INTRODUCTION

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### 2.1. Aim

This task aims at analysing the current EU regulatory framework in order to allow an EU-wide deployment of multi-brand platooning. It is envisioned that the current regulatory framework is not prepared to adopt platooning, thus there will be an extensive analysis of the actual state of European, local and international regulations in order to set the basis for the following subtasks of Task 6.3.

It is very important to have a complete regulatory matrix validated with the OEMs since one of the main goals of the project is to develop recommendations and guidelines for future policies and regulatory frameworks for the wide scale implementation of multi-brand platooning.

### 2.2. Structure of this report

The core body of this report can be divided into four parts:

1. Review of other projects related to platooning (Chapter 3 Ensemble project background, page 11). This part includes the highlights of projects like COMPANION, CARTRE or ETPC.
2. Description of the regulatory framework (Chapter 4 Regulatory framework state of the art, page 24) and the structure of the two main European regulatory bodies, the European Commission and the UNECE, which nowadays are composed by groups of discussion (Chapter 5 Discussion groups, page 31).
3. Presentation and definition of the regulatory matrix linked to ENSEMBLE (Chapter 6 Regulatory matrix, page 40). The work presented in this chapter has been shared and validated with all the OEMs of the consortium, in order to align the vision and objectives. In a later phase this work intends to be presented to interested ETPC partners for gathering their insights and recommendations.
4. Review of the current topics under discussion (Chapter 7 Topics under discussion, page 52). This chapter reviews the main discussions that are taking place at the UNECE in order to detect upcoming changes or modifications in the regulations mentioned in the regulatory matrix.

## 3. ENSEMBLE PROJECT BACKGROUND

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In this chapter, a revision of the output from other relevant research projects in terms of truck platooning will be carried out.

### 3.1. COMPANION

COMPANION (Cooperative dynamic formation of platoons for safe and energy-optimized goods transportation) project was a Seventh Framework Programme Grant agreement no. 610990. It is considered the predecessor of ENSEMBLE. While the ENSEMBLE is focused on multi-brand (inter brand) truck platooning, COMPANION was focused on “one brand (intra brand)” platooning.

The COMPANION project main objective was to develop co-operative mobility technologies for supervised vehicle platooning, in order to improve fuel efficiency and safety for goods transport. At that moment the potential social and environmental benefits inducted by heavy-duty vehicle platoons (or road trains) had been largely proven but the creation, coordination, and operation of such platoons had been mostly neglected. In addition, the regulation and standardization of platoon coordination, and its acceptance by the end-users and the society, needed further attention and research. The proposed idea was to develop a new energy-efficient and user-friendly integrated framework to coordinated driving of heavy-duty vehicles and enabling technology with the potential to revolutionise today’s freight logistics and overall transportation infrastructure.

#### 3.1.1. COMPANION recommendations

The COMPANION project analysis included different legislation levels and was focused on three pillars: the vehicles themselves (as individual elements), their use in platoons regarding semi-autonomous driving and the use of infrastructures.

Platooning in general, is not allowed in the European Union member states. To perform COMPANION demonstration and tests, special permissions were requested to the road authorities for the three trucks forming the project platoon.

In the following lines a description of the conclusions found at the end of the COMPANION project related to the regulatory framework regarding platooning are described.

#### *Recommendations for the Obligatory communication protocol*

The authorization for the circulation of vehicles in platooning shall require clear communication between the different systems in each one of the platoon vehicles such as:

- Brake signal transmission to reduce braking time so the risk of impact is minimized



- Steering signal transmission from the steering system so all vehicles are aware of the the other vehicles
- Light signal transmission to indicate the same signal state to all platoon vehicles
- Information transmission on the state of each vehicle to allow the system to determine possible position changes (state of load, possible breakdowns, braking capacity depending on the braking system, temperature, etc.)
- Multi-brand data standardisation to ensure a safe and clear form of message delivery

Also, other issues like a possible influence of wireless signals on the Electromagnetic Compatibility (EMC) of vehicles have to be considered.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Brake signal transmission	R13	GRVA (former GRRF)
2	Steering signal transmission	R79	GRVA (former GRRF)
3	Light signal transmission	R121	GRE
4	Multi-brand data standardization	New Regulation	GRVA (former GRRF)
5	EMC	R10	GRE
6	Platoon vehicles communication	New Regulation	GRVA (former GRRF)

**Table 1. Obligatory communication protocol summary**

### *In case of availability of ACSF: Automatically Commanded Steering Function*

ACSF is an essential function for the completely autonomous platooning, together with the adaptive cruise control.

A future regulation must consider certain aspects, mainly for safety reasons:

- Functional requirements in normal conditions of autonomous use. The operation of the system in autonomous mode shall be established according to maximum turning speeds, restrictions, communication with the driver, and different operating modes.
- Functional requirements in manual mode. The system shall be useable in manual mode in identical conditions to those of a totally manual system.
- Requirements of robustness of the system and failure modes. The system's sturdiness must be guaranteed to avoid that, in the event of a breakdown, a situation of risk can occur.
- Operational logic and prevalence of the user over the automatic operating mode. Manual systems shall always prevail over automatic systems. All the different modes of autonomous operation, should they exist (manoeuvre mode, alone mode, platoon mode), shall be defined, and different requirements shall be established for each one.



	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	ACSF	R79 or New Regulation	GRRF

**Table 2. ACSF: Automatically Commanded Steering Function summary***For the case of Full-autonomous driving*

Each of the autonomous driving phases supposes both a technological and regulatory challenge. These phases have to show a clear image of the required level of control from the driver and/or the vehicle depending on different situations. The top challenge is regarding the last phase of autonomy (full autonomous driving), in which the vehicle has to be capable to make all the decisions related to driving without the driver's input. For this, the authorities have to fix certain restrictions in favour of road safety by considering aspects beyond technology such as social, labour, legal, and strategic aspects.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Autonomous driving regulations	R13, R46, R48, R79, R89, R121, R130, R131	GRRF, GRE, GRSG
2		Regulation EU N° 1266/2009	European Commission / European Parliament
3	Driving time	Directive 2002/15/EC Organisation of working time in respect of road transport activities Regulation (EC) No 561/2006: Driving time in the road transport sector	European Commission / European Parliament
4	Driving licenses	Directive 2006/126 EC: Driving licenses	European Commission / European Parliament

**Table 3. Full-autonomous driving summary***Recommendations related to Short Safety distance*

Vehicles on platooning will require a shorter safety distance in order to take advantage of the aerodynamic suction for optimal performance. The Vienna Convention states that the minimum distance should be sufficient to avoid a collision, but it does not specify it precisely. Therefore, it should be amended to comply with platooning. This will be possible since the response and reaction times for platoon vehicles are lower than for drivers because of their degree of automation.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Safety distance	Vienna Convention	WP.1

**Table 4. Safety distance summary**

### *Recommendations related to Driver monitoring*

The minimization of driver intervention supposes several advantages and disadvantages. These last are mainly related to road safety and have to be considered in detailed to eliminate or reduce potential accidents. Considering the possible decrease in the level of attention of the driver of the autonomous vehicle, a new regulation is needed to have monitoring systems. This system would allow detecting dangerous situations and alerting the driver in cases such as driver drowsiness or driving under the effects of certain substances.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Somnolence / driver monitoring	New Regulation	GRSG or GRE

**Table 5. Driver monitoring summary**

### *Recommendations related to Driver training*

The technological evolution produced on vehicles in recent years has made driving a very different experience than it used to be before. It is often the case that drivers do not react well to many of the new systems such as Anti-lock Braking System (ABS), Electronic Stability Program (ESP), LKAS and Automatic Emergency Braking System (AEBS), putting themselves and others in danger. It is necessary to renew the contents of the driving training, more so considering all the novelties platooning introduces in driving.

The solution is establishing a new training for platooning drivers as well as for the other road users to know how to interact with each other. For platoon drivers it should include theoretical training on the operation of the specific systems of vehicles in a platoon (HMI for example) on the specific platooning rules and practical training in platooning, including incorporation to, circulation in, and exit from it. The training for drivers outside the platoon shall contain information on how these work and how to interact with them: how they are signalized, in what conditions it is safe to overtake them, etc.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Driving licenses	Directive 2006/126 EC: Driving licenses	European Commission / European Parliament

**Table 6. Driver training summary**

### *Recommendations related to Signalling and markings of road and platoons*

A platoon is a special road user due to its particular characteristics. One of the most relevant characteristics is their dimension (up to now, there is no limitation on how many vehicles can be inside a platoon), so it is necessary to establish a specific signalling system for both platoon and regular users.

Platoon signalling:

- Signalling of the roads informing of the possibility or prohibition of driving in platoon, as well as restrictions such as maximum number of platooning vehicles, time restrictions or restrictions referring to vehicles which can join a certain platoon (due to technical characteristics or the nature of their load).
- Signalling of the vehicles in a platoon informing the rest of important events related to safety, such as detection of an obstacle on the road or exit of one of the vehicles from the platoon. This information may be internal, by means of screens installed in the cabin, or external for those sufficiently important events.

Signalling for other users:

- Road signalling with live information on the position and characteristics of the platoon to the other road users so they can adapt their driving or even take some alternative roads.
- Platoon signalling to inform the rest of drivers of their characteristics and actions so they can adjust to them. An example of this could be a road user who wants to take the following exit, so he must know the length of the platoon in front of him. Vehicles driving behind the platoon shall also be informed when another vehicle driving behind them wants to enter the platoon, so that they are aware that they will be inserted into it.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Road signs	Regulation (EC) No 1071/2009 Road transport operators: conditions for the pursuit of the occupation	Geneva and Vienna Agreement
2	Vehicle signs (HUD/HMI)	R46, R121	GRSG
3	Other users signalling	R48 or New Regulation	GRE

**Table 7. Signalling and markings of road and platoons summary**

### *Recommendations for Additional requirements for periodic technical inspections*

Nowadays Periodical Technical Inspections (PTIs) stations have difficulties verifying the correct operation of advanced vehicle systems. Failures in the electronic systems of functions such as ESP, ABS, engine On-Board Diagnostics (OBD) and others can only be detected using the information available on the dashboard (in many cases insufficient and easy to fiddle with) or reading the vehicle's CAN system. Introduction of more and more systems of this type requires an increasingly exhaustive control of their correct operation, more so considering that in the most advanced phases of automation, these systems shall have a high grade of vehicle control, making a possible anomalous operation dangerously compromise road safety.

The solution is the creation of a new regulation to clearly define what functions shall be verified during PTI; even during type approval for another level of safety. In order to help this verification, the makers of these systems could all work with common standards to reduce the difficulty during PTI.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Technical roadside inspection of the roadworthiness of commercial vehicles	R13, R49, R79, R89, R116, R121, R130, R131	GRRF, GRE, GRSG, GRPE
2		Directive 2000/30/EC: Technical roadside inspection of the roadworthiness of commercial vehicles circulating in the Community	European Commission / European Parliament
3		1997 Agreement	Economic Commission For Europe / UNECE

**Table 8. Additional requirements for periodic technical inspections summary**

Since COMPANION Project ended, work has been done in this direction and an update of Regulation 2014/45/EU on periodic roadworthiness tests for motor vehicles and their trailers is ongoing. It introduces provisions for OEM to deliver information on how to inspect emissions and safety of the vehicles.

### *Recommendations for Modular vehicle combinations (Megatrucks)*

Some EU countries such as Sweden, Finland, Germany, and Spain, have legislation at a national level permitting the circulation of these configurations. It is another way of optimizing road transport that has the same target as platooning: to reduce emissions and to increase safety. However, even if platooning and Euro-Modular vehicles compete for the same goal, it doesn't mean they are incompatible, as Euro-Modular vehicles could have their place in a platoon. For this to be possible, it is vital to give a boost to the rules applicable to Euro-Modular vehicles, converting them into a transport system applicable to international transport.

There is currently a work group on MVC (Modular Vehicle Combinations) who pretends to establish the technical requirements these modules must fulfil so as to be part of a combination of vehicles. Besides the contribution from this group, a regulation has to complement the previous on





defining the conditions, at a European level, for these vehicles to be able to drive internationally. This will mainly affect regulations concerning dimensions and masses.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Masses and dimensions	Regulation (EU) 1230/2012: Type-approval requirements for masses and dimensions of motor vehicles and their trailers	European Commission / European Parliament
2		Directive 2015/719 amending Council Directive 96/53/EC laying down for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic	European Commission / European Parliament

**Table 9. Modular vehicle combinations (Mega-trucks) summary**

Taking into account COMPANION recommendations, it is seen that for the ENSEMBLE project that MVC's (Modular Vehicle Combination) should also establish the technical requirements for communication of brake signals for the vehicle combination when more than two vehicles are in the combination. It will also work with the endurance brake for electrical vehicles and electrical manoeuvrable braking systems.

### *Recommendations on Driving timetables*

Current regulations do not cover certain aspects that may affect the driver's abilities such as influences by type of route, the driving time, the kind of vehicle, and the momentary whether circumstances. Platooning can add some additional points in these regulations. First, the homogeneity of the platoon should be considered, since a great number of events happening in the platoon (incorporations, exits, insertion of other uses, etc.) shall produce a greater amount of stress situations. Second, the percentage of manual vs autonomous route, as the manual mode shall aggravate the driver's level of fatigue. It is therefore necessary to update the regulations taking into account other factors in addition to time.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Driving time	Regulation (EC) No 561/2006: Driving time in the road transport sector	European Commission / European Parliament
2	Working time in respect of road transport	Directive 2002/15/EC Organisation of working time in respect of road transport activities	European Commission / European Parliament

**Table 10. Driving timetables summary**



### *Recommendations related to Incompatibilities and/or restrictions in a platoon*

A platoon is a heterogeneous set of vehicles, each one with its own characteristics and incompatibilities. Even when certain standards are established with the minimum requirements needed to be compatible with a certain platoon, there may be some cases in which a vehicle that fulfils them can't be incorporated into the platoon, due to its system characteristics,.

These incompatibilities may be related to the route, such driving on steeply sloping roads, Euro-Modular vehicles not being permitted to enter in some countries, or transporting loads which cannot access to certain tunnels or urban areas, etc. Other incompatibilities may be with other users in the platoon, for example, vehicles not authorized due to their load (perishable foodstuff or dangerous goods) or type of fuel used.

It is therefore necessary to create a standard to consider these incompatibilities and if it is the case, how to deal with them and which vehicle will have a higher preference to be part of the platoon.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Carriage of Perishable Foodstuffs and Carriage of Dangerous Goods	R105 ADR, ATP	WP.11, WP.15

**Table 11. Incompatibilities and/or restrictions in a platoon summary**

### *Recommendations related to Aerodynamic appendages*

One of the potential advantages of platooning is the energy saving caused by the optimization of the air flow produced by the proximity between the different vehicles which form part of the platoon. In parallel, standards are being developed to allow aerodynamic appendages aimed at increasing energy savings in isolated vehicles.

Obviously, the advantages of both systems may be combined for a greater benefit. However, vehicles equipped with aerodynamic appendages may require greater distances between vehicles. Consequently, the development of platoon regulations needs to take into account aerodynamic appendages, and the other way around. This will mainly affect security/safety and dimension regulations.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Dimensions	Directive 2015/719 amending Council Directive 96/53/EC laying down for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic	European Commission / European Parliament
2	Security issues	New Regulation	GRPE, GRSG

**Table 12. Aerodynamic appendages summary***Recommendations related to IWVTA: International Whole Vehicle Type Approval*

Work is currently being undertaken on the creation of a worldwide approval procedure. This procedure defines various levels of compliance in a way that each country can define which is the lowest level required to put vehicles into circulation in its territory. Currently only passenger vehicles are considered, but in the future commercial vehicles used for platooning will be included. Therefore it is necessary to take into account the minimum requirements demanded to vehicles that may form part of a platoon as well as the individual requirements from each state.

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Worldwide approval	R0 or new Regulation	WP.29

**Table 13 IWVTA: International Whole Vehicle Type Approval summary**

## 1. State of the art evolution

	Topic	Regulation that should be modified or created	Working Group deal with the new gaps found
1	Evolution of the Regulations	R0, R13, R46, R48, R89, R79, R105, R116, R121, R130, R131, Vienna Convention	GRRF, GRE, GRSG, GRPE, GRB WP.29, WP.1

**Table 14. Evolution of the Regulations summary**

## 3.2. CARTRE

CARTRE (Coordination of Automated Road Transport Deployment for Europe) is a project coordinated by ERTICO – ITS Europe. The objective of CARTRE is to accelerate the development and deployment of automated road transport by increasing market and policy certainties.

### 3.2.1. CARTRE recommendations

Regarding the CARTRE recommendations, the list below summarizes the regulatory needs for the short and long term identified in the project.

#### *Recommendations related to Short term regulatory needs*

Short term regulatory needs to get the next important steps on track (2020):

- Common European understanding on necessary digital infrastructure quality/coverage for Level 3
- Joint approach between telecom and vehicle industries to support CAD
- Need for cross-border pilot operation projects for a quick rollout of Level 3
- Common European understanding on safety & security validation (when are the systems safe enough)
- European push in setting up the framework for a safe level 4 series development (new UN Regulation, so-called horizontal regulation on accelerator, brakes, steering, lighting, vehicle access)
- Coordinated European and Member state Programs to support global competitiveness
- Adaption of Road traffic rules in Member states (e.g. Germany update presumably 05/17)
- European approach in order to allow Inner-European borders crossing without changing the responsibilities or duties of the driver

#### *Recommendations related to Long term regulatory needs*

Long term vision on policy and regulatory requirements and European harmonization (2040):

- Pan-European approach on overall mobility solutions for cities (including electric autonomous shared mobility)
- Clear common approach for Cities to coordinate Private and Public Transport
- Role of traffic management

- Safe coexistence of automated vehicles and non-motorized road users

#### **European Union, Japan and any other states (UN Regulation):**

- A first concrete regulatory framework is currently in the work; Highly Automated Driving (HAD) with speeds of up to 130 km/h is estimated to be approved in about 2019.
- Key points are: Further amendment of the “Vienna Convention” and the international road traffic regulations, and possibly the establishment of new, overall (supranational) regulations.
- Amendment of traffic road regulations is in place in order to enable HAD and FAD (Fully Automated Driving) with security driver. The next evolutionary step will represent a further regulatory improvement by 2020 which includes a proposal for the distribution of responsibility between driver and vehicle.

#### **United States:**

- The new “Automated Vehicles Policy” imposes high demands on development and safety verification. The present draft is not specific enough in order to identify critical points. As a matter of fact, the draft does not show any unsolvable demands.
- Entering the market means higher risk of industrial policy hurdles because of software- and safety standards, a certain “America-first” interpretation to protect US industry as well as a “pro-Google” view on regulatory issues (Waymo might suggest their specific solution to be the only safe one because of their mass of data they are able to deliver).

#### **China:**

- At this time no regulatory activities regarding HAD or FAD; however, this situation can change very quickly.
- In general, the risk of restrictions based on industrial policy considerations is ever-present (possible rejection of external tenders or licenses for navigation maps).



### 3.3. ETPC 2016 Challenge event

The ETPC (European Truck Platooning Challenge 2016 event) was a successful experiment with cross-border platooning. Five member states and six European truck manufacturers participated in that 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 [1].

#### 3.3.1. ETPC recommendations

In the following lines, an overview of ETPC 2016 Challenge generic conclusions will be described. In order to understand the complexity of this cross-border platooning project, an example on how the Netherlands Vehicle Authority evaluated test applications is given.

##### *Generic conclusions from the ETPC event*

The main key points taken from the Challenge are as follow [2]:

- National bodies are responsible for the approval of vehicle modifications, based upon European harmonised regulatory base rules.
- Existing national requirements for the approval of prototype vehicles, like platooning trucks, differ.
- The necessary national exemption led to mutual cross country recognition - In total, 19 exemptions were needed to perform the challenge.
- The vehicle assessment varies depending on the country but most countries assess the vehicle, the road and the interface between the trucks and other users.
- Following distance based on redundancy and reliable signals (related to EMC).
- ACEA agrees to set a 0.5 s as a minimum following distance for the demonstration of the 'Challenge'.
- Examples of exemption requirements made for:
  - a. Lay out of motorways and position of the truck platoon on the road (2 lanes, emergency lane, etc.)
  - b. Tunnels: Need to know location and length. The tunnels were considered too short to make system failures likely
  - c. Maximum speed: Set at 80 or 90 km/h. Special requirements for re-forming the platoon

### *Case study for the Netherlands in 2016*

In order to understand how each case was treated within the ETPC 2016 Challenge, the Dutch case has been chosen to serve as an example [3].

In this case, the Netherlands Vehicle Authority evaluates test applications in three stages:

1. Written evaluation, roughly comprising an overview of changes to the vehicle, and the impact these have on safety, and counter measures;
2. Functionality testing (at a closed facility), of aspects the applicant seeks to test on public roads: the 'happy flow test';
3. A stress test at a closed facility. This tests system robustness, both in technical and functional terms.

If this phase is completed successfully, consideration will be given – in consultation with the road manager(s) – as to suitable locations to be opened up and under what circumstances. This may involve recommendations from knowledge institutes like the Road Safety Research Institute (SWOV) or cyber security experts. The exemption lists all relevant circumstances together with the licensed drivers, the duration of the exemption and the vehicles.



## 4. REGULATORY FRAMEWORK STATE OF THE ART

This chapter presents a review of the structure of the regulatory framework concerning vehicles and their systems and components.

### 4.1. Vehicle and component regulatory framework

This regulatory review starts with a global vision of the Working Groups in Geneva and Brussels.

#### 4.1.1. Regulations from the United Nations Economical Commission of Europe (UNECE)

The United Nations Economic Commission of Europe was established in 1947 to encourage economic integration and cooperation among its member countries. It is one of five regional commissions under the administrative direction of United Nations headquarters.

One of its main areas of work is Transport. Their main objective is to promote sustainable transport which is safe, clean and competitive, through the development of freight and personal mobility by inland transport modes, by improving traffic safety, environmental performance, energy efficiency, inland transport security and efficient service provision in the transport sector.

##### *UN Regulations (UNECE)*

In 1958 the United Nations Economic Commission from Europe, in Genève, established an integrated global system for the mutual recognition of vehicle-related product and subsystem approvals. These regulations are accepted by all signatories to the 1958 Agreement (all the countries from the European Union and some others not taking part in the EU) that have adopted each particular regulation within their respective regulatory systems.



Figure 1. UNECE logo

Although voluntary, the UNECE regulatory process has been integrated directly into EU rulemaking such that the use of UN Regulations, where applicable, is often mandatory under EU law.



### 4.1.2. Regulations and directives of the European Commission

The European Commission (EC) is the executive body of the European Union responsible for proposing legislation, implementing decisions, upholding the Union's treaties and day-to-day running of the EU. The European Commission represents the interests of the EU as a whole. The term 'Commission' refers to both the 28 Commissioners and the wider institution itself. There is one member per Member state. Together they take decisions on the Commission's political and strategic direction. Overall, the Commission works under the leadership of a President.



Figure 2. European Commission logo

#### *EU Regulations*

Regulations (EU) from the European Union, in Brussels, (previously named Regulations (EC) from European Commission), are the most direct form of EU law - as soon as they are passed, they have binding legal force throughout every Member State, on a par with national laws. National governments do not have to take action themselves to implement EU regulations. Regulations are passed either jointly by the EU Council and European Parliament, or by the Commission alone.

#### *EU Directives*

Directives (EU) and Directives (EC) from the European Union and the European Commission in Brussels are addressed to national authorities, who must then take action to make them part of national law, and decisions, which apply in specific cases only, involving particular authorities or individuals.

- The **Directive 2007/46 EC** regulates the vehicle type-approval in the European Union. It is the procedure whereby a Member State certifies that a type of vehicle, system, component or separate technical unit, satisfies the relevant administrative provisions and technical requirements. All the motor vehicles are classified in different categories according to its function and weight. The technical requirements of all them are laid down in different regulatory acts announced in an exhaustive list set out in Annex IV of the mentioned Directive. The regulatory acts come from different regulation bodies such as (UNECE) Regulations, Regulations (EU) and Directives (EU), all of them equally mandatory. However, in September 2020, this directive will be repealed by the new Regulation (EU) 2018/858.
- The **Regulation (EU) 2018/858**, published on 14 June 2018 at the Official Journal of the EU and entered into force on the 4 July 2018, will be applicable from 1 September 2020. This new regulation on type approval and market surveillance of motor vehicles will repeal the Directive 2007/46/EC. Although many parts of the Type-Approval procedure will continue intact, there are



important changes introduced as a consequence of the diesel gate scandal. The main changes introduced by this regulation are the new testing regime to ensure cars remain within emission limits and the requirement to conduct a minimum number of checks on cars each year.

- The Directive 2010/40/EU regulates intelligent transport systems (ITS). ITS can significantly contribute to a cleaner, safer and more efficient transport system. A new legal framework (Directive 2010/40/EU) was adopted on 7 July 2010 to accelerate the deployment of these innovative transport technologies across Europe. This Directive is an important instrument for the coordinated implementation of ITS in Europe. It aims to establish interoperable and seamless ITS services, while leaving Member States the freedom to decide which systems to implement.
- The last Delegated Act on C-ITS - [europarl.europa.eu](http://europarl.europa.eu) [4] under Directive 2010/40/EU to adopt delegated act(s) by 2018 is to ensure compatibility, interoperability and continuity of C-ITS services in the deployment and operational use of Union-wide C-ITS services based on trusted and secure communication.



## 4.2. Local legislation for vehicle use and infrastructure

The use of the vehicles such as traffic rules, driving licenses or the general interaction between vehicles are regulated by both the EU directives and the national regulations.

Local bodies can be identified as Ministries that directorate a public service, national/regional administrations or others. In Table 15, a summary of the different responsible authorities and their responsibilities is identified.

Country	Type-approve Authority	#	Road Authority
Belgium	Service Public fédéral (SPF) Mobilité et Transports – Direction générale Mobilité et Sécurité routière – Direction Immatriculation et Homologations des Véhicules (DIV)	E6	Belgian Traffic Legislation wegcode
	Service Publique de Wallonie (SPW) - Direction générale opérationnelle de la Mobilité des voies hydrauliques – Direction Certification et Homologation		
Denmark	Danish Road Safety Agency	E18	
Estonia	Estonian Road Administration	E29	
France	Ministère de la Transition Ecologique et Solidaire, chargé des relations internationales sur le climat - Direction Générale de l'Énergie et du Climat	E2	
Germany	Federal Office for Motorvehicles <i>Kraftfahrtbundesamt</i> KBA	E1	Kraftfahrt-Bundesamt KBA
Greece	Ministry of Infrastructure and Transport – Vehicles Technology Directorate	E23	
Ireland	National Standards Authority of Ireland	E24	National roads authority NRA
Italy	<i>Ministero delle Infrastrutture e dei Trasporti</i>	E3	Autorità di Regolazione dei Trasporti
Netherlands	<i>Dienst Wegverkeer</i> RDW	E4	Rijkswaterstaat Ministry of Infrastructure and water Management
Spain	<i>Ministerio de Industria, Comercio y Turismo</i> MINCOTUR	E9	<i>Dirección General de</i> <i>Tráfico</i> DGT
Sweden	Swedish Transport Agency <i>Transportstyrelsen</i>	E5	
UK	Vehicle Certification Agency VCA	E11	Department for Transport (DfT) – Roads, vehicles and road safety

Table 15. Local bodies for legislation of vehicles use and infrastructures



### 4.3. Exemption process, the ETPC Challenge 2016 experience

This ETPC had an important experience in the exemption procedures between countries involved in the demonstration that took place in April 2016.

ETPC stated that the main issue in the exemption process was to get 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 covered modified vehicles whereby special technology could control the distance between them, being able to reduce the distance below the current limit.

ETPC reviewed the approval process and highlighted the institutes and procedures involved. For each country taken into account for the Challenge, the following questions were answered:

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?

The information was collected from the different countries where the Challenge took place as seen in Table 16: Sweden, Denmark, Southern Germany (Bavaria and Baden-Württemberg), North Germany (Schleswig-Holstein), Belgium, The Netherlands.

	Sweden	Denmark	Southern Germany	North Germany	Belgium	The Netherlands
<b>Vehicle authorities</b>	Trafikverket  National Road Authority  Transportstyrelsen  Road Traffic Authority	Vejdirektoratet  National Road Authority	Baden-Württemberg  Traffic Ministry  Bavaria (Interior Ministry, including traffic)	Schleswig-Holstein  National Authorities	FOD Mobiliteit en Vervoer	RDW  Netherlands Vehicle Authority
<b>Application policy and procedure</b>	Self-reporting.  OEM apply for a prototype license plate	Self-reporting.  Basis of mutual recognition  Application similar to Swedish one	Prescriptive:  Assessment of the vehicle carried out by a Technical Service (TÜV/DEKRA/etc). The rules are strict and it is very organised procedure  Assessment of the vehicle carried out by a Technical Service. The rules are strict and it is very organised procedure. The vehicle assessment include EMC requirements and situations like platoon formation, normal platoon driving, etc.		Prescriptive:  The approval of prototype vehicles in the responsibility of the federal Belgium authorities (FOD). The states of Belgium like Brussels, Flanders and Wallonia are responsible for the exemption.	Prescriptive and Code of Practice:  The ITS admittance procedure involves the gradual accrual of confidence, repetitively and step by step, based on wide-ranging risk analysis.  RDW assessed all vehicle entering the Netherlands
<b>The permit</b>	0,5 sec at 80-90kph permit.  OEM's carry more responsibility	Permit for a specific platooning trucks for the specific date and route with the following time 0,5 s. It was an specific exemption.	Permit with a following time 0.5 s at a max speed of 80 kph.	Permit with a following time 1 s at a max speed of 80 kph.	Same assessment as in the Netherlands. The set following time was 1.0-1.2 s with the maximum speed in Belgium at 90 kph.	Permit with following times ranging from 0.7 to 1.3 s at 80 kph. The redundancy and reliability of systems were processed in the prescribed following distance.

Table 16. Analysis of the national exemption procedures (ETPC)



The ETPC is in favour of adopting a common “Building Blocks” for Truck Platooning test exemptions. Already in the final report of [GEAR 2030, Annex 4](#) [5], a list of building blocks for multi-national use and cross border testing exemptions was presented.

These “Building Blocks” consist in several requirements regarding:

- The applicant
- The driver/monitor/supervisor
- The vehicle
- The infrastructure
- Behaviour
- Admittance testing
- Documentation
- Admittance testing
- The exemption
- Field Operational Tests
- Code of Practice

The overall objective of these “Building Blocks” is to set the basis for a European or global standard.

## 5. DISCUSSION GROUPS

The agreements of vehicles characteristics and road traffic rules are being discussed by several groups in Geneva and Brussels. Some of them are just regulatory groups which are continuously improving their agreements and others are discussing groups looking for the implementation of new technologies in the official framework.

The most important and influencing groups are defined in the following lines.

### 5.1. Harmonization of Vehicle Regulations (WP.29) UNECE

The Inland Transport Committee (ITC) is the highest policy-making body of the UNECE in the field of transport. Together with its subsidiary bodies, the ITC has provided a pan-European inter-governmental forum, where UNECE member countries come together to discuss tools for economic cooperation and negotiate and adopt international legal instruments on inland transport.

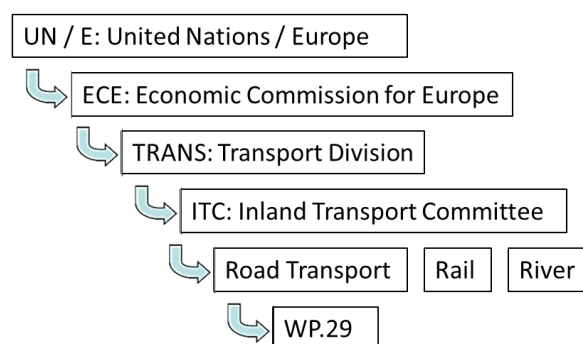


Figure 3. Hierarchical chart of the United Nations Transport Committee

To deal with the transport issues, the ITC is assisted by a number of Subsidiary Bodies. One of them is the World Forum for Harmonization of Vehicle Regulations (WP.29).

The WP.29 is assisted in its work by six specialized subsidiary groups known as Working Parties (Groupe de Rapporteurs GR) covering specific regulatory areas of vehicles. Their aim is to incorporate into its regulatory framework the technological innovations of vehicles to make them safer and more environmentally sound. The six groups are:

- *Noise and tyres : GRBP (former GRB)*

It conducts research and analysis to develop noise requirements for vehicles and, since the dissolution of the GRRF, it includes all the regulation related to tyres. It is comprised of more than 70 experts and they usually convene twice a year.



- *Lighting and Light-Signalling: GRE*

This body prepares regulatory proposals on active safety, specifically regarding vehicle Lighting and Light-Signalling. GRE convenes officially twice a year and entrusts informal groups comprised of more than 80 experts with specific problems that need to be solved urgently or that require special expertise.

- *Pollution and Energy: GRPE*

This group of experts comprised of more than 120 experts conducts research and analysis to develop emission and energy requirements for vehicles. It officially convenes twice a year.

- *General Safety Provisions: GRSG*

This group of experts conducts research and analysis to develop general safety requirements for vehicles, in particular buses and coaches. GRSG convenes officially twice a year and entrusts informal groups of more than 100 experts with specific subjects that need to be considered urgently or that require special expertise.

- *Passive Safety: GRSP*

This group of experts conducts research and analysis to develop passive safety requirements for vehicles. GRSP convenes officially twice a year and entrusts informal groups of more than 80 experts with specific problems that need to be solved urgently or that require special expertise.

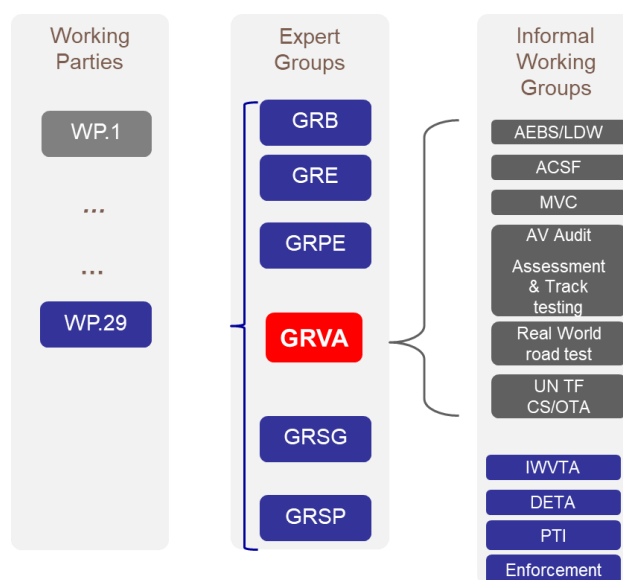
- *Automated Driving: GRVA (Former GRRF)*

At its February 2018 session, the ITC acknowledged the importance of WP.29 activities related to automated, autonomous and connected vehicles and requested WP.29 to consider establishing a dedicated subsidiary Working Party.

Following this request, WP.29, at its June 2018 session, decided to convert the Working Party on Brakes and Running Gear (GRRF) into a new Working Party on Automated/Autonomous and Connected Vehicles (GRVA).

The Working Parties and its subsidiary Working Groups can be observed in Figure 4.

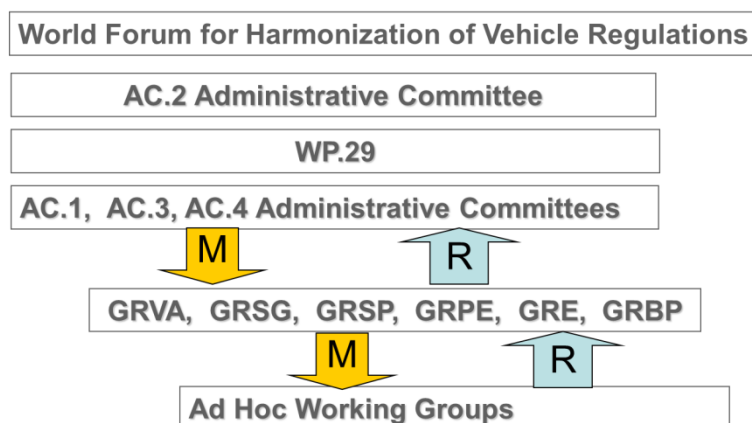




**Figure 4. UNECE Working Groups**

To include any novelty, modification or extension in the regulatory acts of the vehicle type approval, a new technical necessity should be announced in the WP.29 (directly by their members or as a suggestion coming from the Ad Hoc working groups). Once the discussion about this necessity is accepted, the technical requirements for the new regulation are developed in a specific working group (Ad Hoc Working group). Finally, it is presented to the correspondent responsible GR. After the proposal has been discussed and accepted in technical terms it is sent to the WP29 where its practicability will be discussed and accepted.

Together with the WP.29 the administrative committees AC.1 AC.2 and AC.3 (council about the 1998 Geneva agreement, 1958 Geneva agreement and the 1997 Vienne agreement) will give their approval. The summarized process can be seen in Figure 5.



**Figure 5 Regulation acts approval process**

## 5.2. Global Forum for Road Traffic Safety (WP.1) UNECE

The UNECE pioneered road safety activities in the United Nations system with the establishment of an Ad Hoc Working Group on the prevention of road accidents in 1950. In 1988, the Working Party on Road Traffic Safety (WP.1), an intergovernmental body, was established. The Working Party changed its name to “Global Forum for Road Traffic Safety (WP.1)” in 2017.

Global Forum for Road Traffic Safety (WP.1) focuses on improving road safety and its primary function is to serve as guardian of the United Nations legal instruments aimed at harmonizing traffic rules.

Recently, WP1 has adopted a non-binding legal resolution serving as a guide for the countries which are Contracting Parties to the 1949 and 1968 Conventions on Road Traffic in relation to the safe deployment of highly and fully automated vehicles in road traffic [6].

The resolution offers recommendations to ensure the safe interaction between automated vehicles, other vehicles and more generally all road users, and stresses the key role of human beings; drivers, occupants or other road users. While the Global Forum intends to amend the resolution as technology develops and as experience accumulates regarding the use of highly and fully automated vehicles in road traffic, there have been calls for turning attention to the legal contents of the 1949 and 1968 Conventions on Road Traffic.

## 5.3. European Commission and its Directorate-General sections

The Commission, similarly to the UNECE structure, is organised into policy departments named “Directorates-General” or DGs which are responsible for different policy areas. These departments develop, implement and manage EU policy. In parallel, the Commission also has Executive Agencies, which manage programmes set up by the Commission for a limited period of time to manage specific tasks, and Service Departments, which deal with particular administrative issues of the Commission.

Among all the DGs, Service Departments and Executive Agencies that comprise the European Commission, the following ones are the most related to current transport issues:

- *DG CLIMA: Climate Action*

This Commission directorate general is responsible for EU policy on climate action and it leads international climate negotiations for the EU.

- *DG GROW: Internal Market, Industry, Entrepreneurship and SMEs*

This Commission directorate general is responsible for EU policy on the single market, industry, entrepreneurship and small businesses. DG Grow is in charge amongst others of the regulation applying to transport industry such as the vehicle type-approval and it was the promoter of the High Level Group GEAR 2030.

- *DG MOVE: Mobility and Transport*

This Commission directorate general is responsible for EU policy on mobility and transport. Relevant discussion groups like sustainable and intelligent transport, road transport and road safety or Motor Vehicle Working Group belong to this DG.

- *DG RTD: Research and Innovation*

This Commission directorate general is responsible for EU policy on research, science and innovation, with a view to help create growth and jobs and tackle our biggest societal challenges. . A specific Directorate is dedicated to Transport.

### 5.3.1. European Union strategy on Automated Driving (AD)

The EC published a communication on the 17<sup>th</sup> of May 2018 adopting a common EU vision on automated mobility [7].

The 3 main axes were:

1. Developing key technologies and infrastructures (e.g. though testing)
2. Ensuring automated mobility is safe and future-proof legal framework
3. Addressing societal concerns, in particular jobs and ethical issues

A brief description of these axels comes below.

#### *1. Developing key technologies and infrastructures (e.g. through testing)*

The Commission will continue encouraging measures to promote the Research (Horizon Europe/CEF) and infrastructure (e.g. 5G, ITS G5) for the identified use cases. The Commission has focused its efforts by launching:

- New partnership/strategic planning in the next multi-financial framework
- One EU platform for testing and deployment activities
- Provide Galileo (Galileo is the European Union's Global Satellite Navigation System – GNSS), which provides accurate positioning and timing information, high accuracy services for free



## 2. Ensuring automated mobility is safe and future-proof legal framework

The Commission is also working on providing a full legal framework in order to introduce new technologies and vehicles in a safe and controlled way. The priorities are:

- Promote new technologies: provide guidelines on Article 20 of Directive 2007/46/EC
- Promote transparency: Documentation to be provided by manufacturer and documentation to be shared with other type-approval authorities based on building blocks (ODD, perception system, driver monitoring, fall back, driver complacency/misuse, etc.)
- Harmonized method to assess and validate the vehicle safety: guidelines on risk analysis, tailored tests, best practice on HMI, cybersecurity.
- First draft proposal in TCMV of 27/9/2018, consultation MVWG, Finalization by 2018
- Intensify coordination on traffic rules and ensure interoperability of road safety messages (ITS)
- Assess options for data framework and legislation on data of public interest.
- New topics to be regulated. The Commission has a clear schedule for some of the topics as presented in Table 17 and Table 18. As it can be seen, platooning is one of the new topics included in their strategy and will be regulated in a near future.

New Topic	Expected date	Responsible
Longitudinal-Lateral control	2018-19 (simple)/ 2020 (more advanced)	GSR + UNECE
Understanding of the surrounding area	2018-19 (simple)/ 2020 (more advanced)	GSR + UNECE
Driver readiness monitoring	Nov 2018-19(simple)/ 2020 (more advanced)	GSR + UNECE
EDR for automated vehicles	Nov 2018-2020.	GSR + UNECE
Drowsiness and attention detection	2018-2020	GSR +UNECE
Cybersecurity	Q4 2018 (UNECE)+GSR: 2019	GSR +UNECE
Over the air update	2018-2019	EU+ UNECE
<b>Platooning</b>	<b>Q4 2019</b>	<b>EU</b>
Issues related to Reg. 858/2018	2018-2020	EU

**Table 17 List of topics to be addressed in the near future (2019-2020)**

Item	Implementation	How to achieve / legal instrument	Existing basis
Phase 1 (IA date: 1/9/2021 for new types)			
Automated vehicles: systems to replace the driver's control of the vehicle, including steering, accelerating and braking	Start work: Q3/2018  Finish work: Q4 2020	Informal group just started in UNECE (ITS/AD)  Flagged as a priority in Geneva  New testing method to be established (JRC support for the method)	A first simple use case (level 3/4 lane keeping) under discussion under UN/ASCF group (target: Q1 2019).  Discussion on new method to be held in parallel in the EU.
Automated vehicles: systems to provide the vehicle with real-time information on the state of the vehicle and the surrounding area;	Start work: Q3/2018  Finish work: Q4 2020	Informal group UNECE just started in. (ITS/AD)  Flagged as a priority in Geneva  New testing method to be established	A first simple use case (level 3/4 lane keeping) under discussion under UN/ASCF group (target : Q1 2019)
Automated vehicles:  driver readiness monitoring systems	Start work: Q4/2018  Finish work: Q4 2020	Informal group just started in UNECE.(ITS/AD)  Flagged as a priority in Geneva  New testing method to be established	A first simple use case (level 3/4 lane keeping) under discussion under UN/ASCF group TRL study on existing technologies finalized.
Automated vehicles: event (accident) data recorders for automated vehicles	Start work: Q4/2018  Finish work: Q4 2020	Flagged as a priority in Geneva  New testing method to be established	Similarities with classical EDR for data access
Connected vehicles:  cybersecurity	Start date: Q1/2017  Finish work: Q4 2019	Informal group in UNECE. (ITS/AD) is developing a new regulation on cybersecurity.  This regulation could be made mandatory in GSR.	
Phase 2 (IA date: 1/9/2023 for new types)			



Automated vehicles: harmonised format for the exchange of data for instance for <b>multi-brand vehicle platooning</b>	Start work: Q1/2020  Finish work: Q3 2022	EU delegated act on an harmonised format for the exchange of data for instance for multi-brand vehicle platooning	EU project running.
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Table 18. List of topics to be addressed in the near future

### 3. Addressing societal concerns, in particular jobs and ethical issues

It consists in monitoring, consulting and discussing on societal impacts. The Commission has already set efforts on that by developing a study on the socio-economic effects of AD in Europe [8].

In parallel, the Commission will considerate the support of the acquisition of new skills and the transition on the labour market.

Finally, the Commission is considering to set up a dedicated EU Forum on the specific ethical issues related to driverless mobility.

#### 5.3.2. European Union strategy on truck platooning

The Commission has identified the automation use cases which are relevant from a public policy perspective for the next decade but will remain open to considering other possible new use cases being developed in the next years. They expect that truck platooning convoys will be available by 2020.

On vehicle-to-vehicle communications, the Commission follows a technology-neutral approach in line with the EU Strategy on Cooperative Intelligent Transport Systems [9] and has not proposed mandatory deployment of specific technologies at this stage. However, for certain applications such as platooning there is an expressed need for regulation to ensure data standardisation and of vehicle communication protocols across different brands and ensure proper response from the vehicles [11]. Platooning can lead to an automation use case where vehicle-to-vehicle communication is essential.

The Commission is proposing to regulate platooning under the revision of the General Safety Regulation for motor vehicles to ensure standardisation of data exchange across different brands. The implementing legislation will build on the results of the call on platooning (2018-2020) in the Horizon 2020 research and innovation framework programme and complement the delegated Regulation on Cooperative Intelligent Transport Systems.



### 5.3.3. The industry, views and priorities

During the first session of the GRVA in September 2018, the International Organization of Motor Vehicle Manufacturers (OICA) and the European Association of Automotive Suppliers (CLEPA) presented the view from the industry and its priorities [10].

Among the topics already included in the GRVA structure, they highlighted three “missing” items: level 2 hands-off lane keeping, Heavy Commercial Vehicle HCV trailers and Platooning.

According to the road map presented, the regulatory framework for platooning should be approached in two phases; firstly in terms of longitudinal control only (2018-2022) and secondly considering platooning with longitudinal and lateral control (2020-2025).



## 6. REGULATORY MATRIX

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This chapter presents and describes the regulatory matrix, already validated and commented with the OEMs, in order to set the basis for the next deliverables to be prepared inside Task 6.3.

In addition to the matrix and its comments, other topics like ADR or tunnel restrictions will be exposed so as to have a clear image of the current limitations of truck platooning.

### 6.1. Regulatory matrix validation

To assess which regulations could affect to this new stage in platooning, as a starting point, the COMPANION matrix was used and updated with the latest changes in regulations since the COMPANION project ended in 2016.

For this reason, the same approach defined in the COMPANION project will be used (the analysis has been divided in three main sections: vehicles and their components, the use of vehicles and platoons and, finally, the use of infrastructures). This approach aims to use a matrix reflecting all the current regulations and directives that may affect or limit the current implantation of platooning technology. This matrix will be the base needed to identify the gaps in the regulatory framework. In a next step, recommendations will be given to cover these gaps identified and to create the future regulatory framework.

As the basic approach to these regulations was already discussed, it is intended to focus only on the changes that may have affected these regulations, and the implementation of new ones.

The updated version of the matrix will be as follows:

- Regulatory matrix, Part 1 and Part 2 (Table 19 and Table 20): presents all the current regulations and those under discussion as well as all the directives that will need to be reviewed or modified in order to enable the deployment of truck platooning. The regulations indicated in darker colour are elaborated in the next paragraphs.
- Regulatory matrix, Part 3 (Table 21): shows the list of mandatory and recommended standards that should be respected.



		Vehicle							Use			Infra.	Discussion Groups	Observations		
		Distance between the vehicles	Automatic steering direction	Indicator lights	Special vehicles	Devices for indirect vision	On-board system device	Tachograph	Masses and dimensions	Technical conditions of motor vehicles	Traffic regulations and driving licences	Driving hours and rest periods			International transport of goods	Road user charges
UNECE regulations	UN R10 Electromagnetic compatibility EMC						x								GRE (UNECE)	Every system installed in the vehicle shall be isolated to electromagnetical parasitic radiation.
	UN R13 Braking provisions														GRVA (UNECE)	UN R13, related also with UN R131, are considered relevant because platoon will need of complex electronic braking systems
	UN R46 Indirect vision devices					x									GRSG (UNECE)	UN R46 is considered because wing mirrors and other devices will need to be connected somehow
	UN R48 Installation of lighting and light-signalling devices			x											GRE (UNECE)	UN R48 Could define special devices required for indicated platooning universally.
	UN R79 Steering equipment		x												GRVA (UNECE)	UN R79 is crucial if transversal driving operations are expected to be allowed in the platoon
	UN R89 Speed limitation device	x													GRVA (UNECE)	UN R89; Speed limitation device will have to be adaptative depending on the situation.
	UN R105 Vehicle for the carriage of dangerous goods ADR				x							x			GRSG (UNECE)	UN R105; The goods carried by differents members of the platoon might be incompatible
	UN R121 Hand controls tell-tales and indicators (HMI)						x								GRSG (UNECE)	UN R121; HMI factors will need to be taken into account
	UN R130 Lane departure warning system LDWS, LKS		x												GRVA (UNECE)	UN R130 will have to include platoon options not to interfere with the system.
	UN R131 Advanced Emergency Braking System AEBS	x													GRVA (UNECE)	UN R13, related also with UN R131, are considered relevant because platoon will need of complex electronic braking systems that could override those systems.
	Treaty: Carriage of Perishable Foodstuffs ATP				x							x			UN WP 15	Long term platooning could affect the state of the payload: thus, it should be discussed wether this kind of vehicles will have special provisions or not.

Table 19 Regulatory matrix (part 1)



		Vehicle							Use				Infra.	Discussion Groups	Observations	
		Distance between the vehicles	Automatic steering direction	Indicator lights	Special vehicles	Devices for indirect vision	On-board system device	Tachograph	Masses and dimensions	Technical conditions of motor vehicles	Traffic regulations and driving licences	Driving hours and rest periods	International transport of goods			Road user charges
EU directives & regulations	Regulation (EU) 2018/858 Approval and market surveillance.														EC Working group	Article 39 of Regulation (EU) 2018/858 introduces the exemptions for new technologies or new concepts
	Regulation (EU) 1230/2012 masses & dimensions							x							MVWG Masses & Dimensions subgroup	The total length regarding platoon will have to be considered somewhere.
	Regulation (EU) 351/2012 LDWS		x												EC Working group	Same as UN R130
	Regulation (EU) 347/2012 AEBS	x													EC Working group	Same as UN R131
	Regulation (EC) 165/2014 & R(EEC)3821/85 Tachograph						x								EC Working group	Tachograph will have to consider the possibility of driving under a "Platoon driving mode"
	Regulation (EC) 1071/2009 Road operators								x						EC Working group	Could change to adapt to the user.
	Regulation (EC) 561/2006 Driving time									x					EC Working group	Could change to adapt to the user.
	Directive 2011/82/EU Information on road safety								x						EC Working group	Could change to adapt to the user.
	Directive 2006/126 EC Driving licenses								x						EC Working group	Could change to adapt to the user.
	Directive 2006/103/EC Road taxes											x			EC Working group	Could change to incentivate the platooning economically.
	Directive 2002/15/EC Driving time									x					EC Working group	Could change to adapt to the user.
	Directive 2015/719/EC international dimensions & weights												x		EC Working group	
	Directive 2014/47/EC Commercial vehicles roadworthiness test (roadside)								x						EC Working group	
	Directive 2014/45/EU Commercial vehicles roadworthiness test								x						EC Working group	May add special provisions to assess Platooning vehicles.
	Regulation (EC) No 595/2009 and Regulation (EU) 2017/2400: Determination of the CO2 emissions and fuel consumption of HDV	General impact													EC Working group	Could add special provisions.
	Regulation (EC) No 595/2009 and Regulation (EU) No 582/2011: Emissions from heavy duty vehicles (Euro VI)	General impact													EC Working group	A platooning vehicle could be indicated in the plate.
	Regulation (EU) No 19/2011 Statutory Plate	General impact													EC Working group	Somewhere in the truck will have to be indicated if the truck has been type approved to do platooning. The statutory plate could be an option
Under discussion	Draft UN Regulation - Cibersecurity	x	x	x		x	x								GRVA (UNECE)	This regulation is under discussion and specially apply to complex electronics vehicle.
	Draft UN Regulation - Over the air updates	x	x	x		x	x								GRVA (UNECE)	This regulation is under discussion and specially apply to complex electronics vehicle.
	Draft UN Regulation - Blindspot			x											GRSG (UNECE)	This regulation is under discussion and specially apply to complex electronics vehicle.
Local regulations		x							x	x	x	x	x	x		

Table 20 Regulatory matrix (part 2)



		Security	Testing	Vehicle to infrastructure	Vehicle to vehicle	Vehicle to everything	Vehicle to user
Mandatory ETSI Standard	<b>ETSI EN 302 663</b> Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band	X		X	X	X	
	<b>ETSI EN 302 571</b> Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU	X		X	X	X	
	<b>ETSI EN 302 895</b> Vehicular Communications; Basic Set of Applications; Local Dynamic Map (LDM)			X	X	X	
	<b>ETSI EN 302 931</b> Vehicular Communications; Geographical Area Definition			X		X	
	<b>ETSI EN 302 636</b> Vehicular Communications; GeoNetworking.			X			
Recommended ETSI Standard	<b>ETSI TS 102 965</b> Application Object Identifier (ITS-AID); Registration.			X	X	X	
	<b>ETSI TS 103 175</b> Cross Layer DCC Management Entity for operation in the ITS G5A and ITS G5B medium.			X	X	X	
	<b>ETSI TS 102 687</b> Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part.			X	X	X	
	<b>ETSI TS 103 248</b> GeoNetworking; Port Numbers for the Basic Transport Protocol (BTP)			X			
	<b>ETSI TS 102 724</b> Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band			X	X	X	
	<b>ETSI TS 102 792</b> Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range	X		X	X	X	
	<b>ETSI TS 102 942</b> Security; Access Control	X					X
	<b>ETSI TS 102 943</b> Security; Confidentiality services	X					X
	<b>ETSI TS 102 940</b> Security; ITS communications security architecture and security management	X					
	<b>ETSI TS 103 097</b> Security; Security header and certificate formats	X					
	<b>ETSI TS 102 731</b> Security; Security Services and Architecture	X					
	<b>ETSI TS 102 941</b> Security; Trust and Privacy Management	X					
	<b>ETSI TS 102 917</b> Test specifications for the channel congestion control algorithms operating in the 5,9 GHz range;	X	X	X	X	X	
	<b>ETSI TS 102 916</b> Test specifications for the methods to ensure coexistence of Cooperative ITS G5 with RTTT DSRC; P		X				
	<b>ETSI TS 102 868</b> Testing; Conformance test specifications for Cooperative Awareness Basic Service (CA)		X				
	<b>ETSI TS 102 869</b> Conformance test specifications for Decentralized Environmental Notification Basic Service (DEN);		X	X			
	<b>ETSI TS 103 191</b> Conformance test specifications for Facilities layer protocols and communication requirements for infrastructure services		X	X			
	<b>ETSI TS 102 871</b> Conformance test specifications for GeoNetworking ITS-G5		X	X			
	<b>ETSI TS 103 096</b> Testing; Conformance test specifications for ITS Security	X	X				
	<b>ETSI TS 102 894</b> Users and applications requirements	X					X
	<b>ETSI TS 103 301</b> Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services			X	X	X	X
	<b>ETSI TS 102 637</b> Vehicular Communications; Basic Set of Applications			X	X	X	X
FUTURE ISO	<b>ISO 20077</b> Road vehicles - Extended vehicle concept (ExVe)						
	<b>ISO 20078</b> Road vehicles - Extended vehicle (ExVe) "web services": Access, security, control						
	<b>ISO 20080</b> Road vehicles - Information for remote diagnostic support						

Table 21 Regulatory matrix (part 3)



### 6.1.1. Regulation and standard frames regarding vehicles

#### **Regulations related to Table 19 Regulatory matrix (part 1)**

##### **UN Regulation No. 13: Uniform provisions concerning the approval of vehicles with regard to their braking system**

This regulation is considered to be relevant, as every complex system will be declared in the future, as it will be every relationship between each system that could affect the braking system. The “Platooning” function will have between its main tasks to manage the brake system in certain cases, reason for which it may impact the way the industry reflects the interaction between each function.

##### **UN Regulation No 79: Uniform provisions concerning the approval of vehicles with regard to steering equipment**

Since the COMPANION project was released, this regulation has suffered a lot of modifications. In its current version (series of amendments 03) the official text aims to regulate the main automated functions that are being implemented in the current vehicles.

In the Platooning case, the functions to be highlighted are mainly:

- Automatically commanded steering function (ACSF) of category B2. This function is able to maintain the vehicle within its lane by influencing the lateral movement of the vehicle for extended periods.
- Corrective steering functions (CSF). This function also controls the steering system of the vehicle, but only for brief periods of time when the path of the vehicle does not match the desired by the driver.
- Emergency steering function (ESF). This function controls the steering system of the vehicle for brief periods of time, but only to avoid a potential collision.

All this functions are directly correlated to the platooning, and their requirements could be deemed as mandatory. However, this regulation still requires the driver to be at constant control of the steering system, which should change to allow platooning.

##### **UN Regulation No. 105: Uniform provisions concerning the carrying of dangerous goods**

This regulation regarding the road transportation of dangerous goods, is constantly under development. In its last version, the wiring of the vehicle must comply with ISO 14572:2011, as well as the rest of the old requirements.

Besides the goods being allowed to circulate in certain countries, it may be forbidden or restricted for this kind of vehicles to be part of a platoon, by themselves or in combination with other ADR vehicles.

A more general view of the ADR provisions is made after in the document.

### **UN Regulation No. 130 // Regulation (EU) 351/2012 Uniform provisions concerning the lane departure warning system.**

This regulation is a candidate to be discussed if basic provisions of ACSF function category B2 are mandatory. In such a case, lane departure warning system may not require any modification, nor be an obstacle to the platooning functions. Automatically switching off/on the function depending on the vehicle being participant in a platoon may be a requirement.

### **UN Regulation No. 131 // Regulation (EU) 347/2012 Uniform provisions concerning the advanced emergency braking system.**

The need of a warning system able to warn the driver whenever a collision may occur is present in this regulation, Due to the distances between vehicles when platooning, the possibilities of this system detecting a false positive are very high.

Taking this into account, the classical vision of this regulation is not enough to cover the platooning case. At least an exemption of the function working in this case is needed, being override by the system. The regulation can also include the prescriptions of minimal performance while the vehicle to vehicle communication impels the vehicle to brake, or it could be included in a completely different regulation.

### **Treaty: Carriage of Perishable Foodstuffs ATP**

This treaty aims to regulate the transport of different kinds of food among the countries that signed the agreement. Besides the discussions of the allowance of the load to be transported in each country, the platooning technique must be taken into account especially when carrying refrigerated payload, as the necessary airflow in front of the vehicle could be interrupted by a too close vehicle being driven in the front.

Taking this into account, trucks carrying perishable food may have limited allowance to platoon, or be required to monitor its equipment status.



### **Regulations related to Table 20 Regulatory matrix (part 2)**

#### **Regulation (EU) 2018/858 Approval and market surveillance**

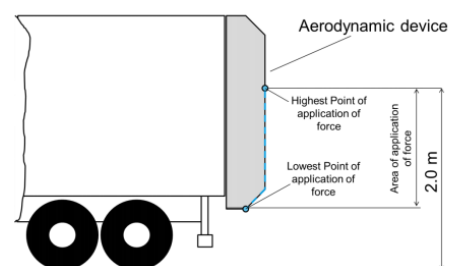
The framework regulation 2007/46 has been repealed, being this regulation now the reference for type approval and, as a novelty in Europe, the concept of market surveillance. The responsible organisation of this surveillance must be different from the one responsible for the type approval, at least in organization structure.

This market surveillance authority shall at least perform one test for every 40.000 vehicles produced in the member state, or a minimum of 5 if the number of 200.000 manufactured vehicles is not reached.

Being this platooning technology new, the will of the designated authorities to check that it is working according to defined regulations, may lead to several surveillance tests being carried in the next years. The standardisation of the platooning protocol will help the member states to carry over those checks, as having another truck able to platoon of any other brand may be sufficient to check its behaviour.

#### **Regulation (EU) 1230/2012: Regarding maximum masses and dimensions**

Besides the classical limits to weights per axle, width length and height, the European Commission is preparing a proposal to specify the requirements to the safety aspects of aerodynamics matters in commercial vehicles. Specifically, the Commission aims to better define the rear aerodynamic appendix, not being considered as a part of the length dimension if it breaks (in a non-brittle way) under a force of 4000 N. It also aims to define the concept of “Elongated Cab”, as a way to improve frontal aerodynamics.



**Figure 6 Application force on the aerodynamic appendix**

Although this new definitions can improve the general aerodynamics of the vehicle, it is not clear whether this or the classic truck is the better option for platooning. The standard platooning logic must take into account that this kind of vehicles is going to be present in the roads, changing the distances gaps in with the platooning is effective.

In addition, maximum length of the platooning could be restricted in order not to interfere with the rest of road users. This restriction could be included whether in a dedicated regulation or with the rest of dimensions restrictions.

### **Regulation (EU) 165/2014 adapting the Regulation EEC N°3821/85: Recording equipment in road transport (digital tachograph)**

As previously discussed in the Companion project, there would be no problem in maintaining the same regulation working: nevertheless, it could be interesting redefining the time that the vehicle spends platooning as “non-conventional driving time”, allowing maybe more hours of circulation without official rest. The fact that in the Regulation EU N° 165/2014 the satellite location was declared mandatory could help to have this status automatized.

Article 34 in Regulation EU N° 165/2014 defines the drawings to identify the different status of the driver. A new drawing may be created to define the “platoon” status.

### **Regulation (EU) 2014/45: Regarding roadworthiness test**

The demonstrator platoon shall have no problem, as they will have passed their roadworthiness test in its member state. As future requirement, the platooning function may be checked as part of the roadworthiness tests. That could be done via tell-tale, as many other systems in the vehicle, or connecting directly to the vehicle, with a system similar to the OBD used to control emissions.

### **Regulation (EU) No 19/2011: Regarding the Statutory Plate**

As a simple way to identify which vehicles are allowed to platoon, this function may be indicated in the statutory plate, in order to facilitate the road side inspections.



## 6.2. Safety gaps

Safety distances are a key element when talking about platooning. Most of the countries reflect in their national regulations the obligation of having a minimum distance (which can be defined in distance or time); nevertheless, they normally do not define an objective measure to completely define it.

As it was discussed in the COMPANION project, the distances between the vehicles was the most unknown and subjective matter discussed. Within this project we aim to define all the security distances in every country on the EU, so it is known where national regulations may change and in which degree.

Country	Regulatory text	Section / Paragraph	Measured as				Comments
			Time	Distance	Subjective	other	
Germany	German road traffic regulations	Section 4		X	X		-Keep enough distance as general rule -If the vehicle is longer than 7 meters, enough distance to have another vehicle in front of you -Vehicles with more than 3,5 T of mass must have more than 50 meters of distance when the speed is higher than 50 km/h.
Austria	Straßenverkehrsordnung	Art. 18	X	X	X		-It is mandatory having a adequate security distance. -Having less of 14 meters of distance is considered an infringement. -After a railed vehicle, having at least 20 meters of distance. -For industrial vehicles: having more than 50 meters in local roads.
Belgium	Code de la route	Art. 10.1			X		Vary security distance depending on speed.
Bulgaria		Art. 20			X		Change this security distance depending on speed and load.



Cyprus	The official highway code	Article 126	X	X			-Rule of two seconds and several recommended distances: up to 4 seconds when there is bad weather.  -5 meters of distance between vehicles when there is a complete stop in a tunnel.
Spain	Real Decreto 1428/2003	Art. 54			X		Enough to guarantee the vehicle safe stop.
France	Code de la route	Article R412-12	X				More than two seconds (cars), and 50 m (trucks).
Ireland	Rules of the road	Pag 116		X			RSA <u>recommends</u> several safety distances depending on the speed.
Italy	Codice della strada	Art. 149		X			100 meters outside of build-up areas, 20 meters always when driving after industrial machinery.
Luxembourg	Plan général du c. de la r.	Paragraphe 2 point 20, page 14	X				More than two seconds.
Malta	Highway code	Art. 279		X	X	X	Rule of two seconds and several recommended distances: up to 4 seconds when there is bad weather.
Netherlands			X				Less than a second is considered infringement. Rule of two seconds is applied.
Portugal	Código da Estrada	Artigo 18º (pag 17)			X		Enough to guarantee the vehicle safe stop, paying special attention to VRU.
UK	Highway code	Article 126	X	X			-Rule of two seconds and several recommended distances: up to 4 seconds when there is bad weather. -5 meters of distance between vehicles when there is a complete stop in a tunnel.

Table 22. Safety distance legislation per Country

The information showed in Table 22 may be used in the future to reach a point where minimum modifications in the national laws are required to allow platooning. In the same way, the systems shall detect the country where is operating to respect special provisions that could be not directly related to platooning and are reflected in the traffic codes.

To complete all the countries in the EU, some information is still missing. The objective is to identify at least, all the needed information to have the demonstrator route covered and analyzed.



### 6.3. ADR

The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) was done at Geneva on 30 September 1957 under the United Nations Economic Commission for Europe, and it entered into force on 29 January 1968.

The Agreement itself is short and simple. The key article is the second, which says that apart from some excessively dangerous goods, other dangerous goods may be carried internationally in road vehicles subject to compliance with:

- the conditions laid down in its Annex A for the goods in question, in particular as regards their packaging and labelling; and
- the conditions laid down in its Annex B, in particular as regards the construction, equipment and operation of the vehicle carrying the goods in question.

Annexes A and B have been regularly amended and updated since the entry into force of ADR. Consequently to the amendments that entered into force on 1 January 2017.

In summary, ADR is an Agreement between States and there is no overall enforcing authority. In practice, highway checks are carried out by Contracting Parties, and non-compliance may then result in legal action by national authorities against offenders in accordance with their domestic legislation. ADR itself does not prescribe any penalties.

ADR will have to be taken into account when talking about platooning. Vehicles being part of a platoon might have some incompatibilities between them when talking about the goods they are carrying. Attention will be paid to this issue along the project.

### 6.4. Tunnel restrictions

When applying restrictions to the passage of vehicles carrying dangerous goods through tunnels, the competent authority shall assign the road tunnel to one of the tunnel categories defined in the section 1.9.5.2.2. of European Agreement concerning the International Carriage of Dangerous Goods by Road.

Tunnel characteristics, risk assessment including availability and suitability of alternative routes and modes and traffic management considerations should be taken into account.

In 2007 the tunnel restriction code was introduced with the European Agreement concerning the International Carriage of Dangerous Goods by Road and as a consequence, all tunnels in the European Union are allocated to a tunnel restriction category. There are five categories in total:

**A** No restriction for hazardous goods.

**B** Prohibited for the transport of hazardous substances which could cause a very large explosion.

**C** The same restriction as for B, plus hazardous goods which could cause a large explosion or the extensive release of toxic substances.

**D** The same restrictions as for C plus hazardous goods which could cause a large fire.

**E** Prohibited for the transport of all hazardous substances. There are some exceptions for certain radioactive substances, clinical waste and samples.

ENSEMBLE project will have to take into account these restrictions in case the trucks being part of a platoon are carrying dangerous goods.

Furthermore, considerations regarding safety distance between vehicles when driving inside a tunnel will have to be analysed as well.

## 6.5. VECTO

VECTO is a simulation software that can be used cost-efficiently and reliably to measure the CO<sub>2</sub> emissions and fuel consumption of high duty vehicles for specific loads, fuels and mission profiles (e.g. long haul, regional delivery, urban delivery, etc.), based on input data from relevant vehicle components.

The Commission has proposed that, as of 1 January 2019, truck manufacturers will have to calculate the CO<sub>2</sub> emissions and fuel consumption of new vehicles they produce for the EU market, using the new Vehicle Energy Consumption Calculation Tool (VECTO). This information will be declared for the registration of vehicles under the EU type-approval legislative framework, in application of the so-called certification regulation.

With this new monitoring and reporting scheme, the Commission will collect the declared CO<sub>2</sub> emissions and fuel consumption data via a monitoring and reporting system. The collected data on CO<sub>2</sub> emissions and fuel consumption together with other relevant technical information on the vehicles, including the aerodynamic drag, will be made publicly available by the European Environment Agency on behalf of the Commission, starting in 2020 to cover data monitored in 2019. The new system will complement the existing EU reporting scheme for cars and vans.

The scope of the regulation is set to be amended in the future to also cover smaller trucks, buses and coaches. This will allow monitoring of CO<sub>2</sub> data from these vehicle categories too [15] .

When talking about ENSEMBLE project, platooning can be seen also as a future reason to amend this regulation. Trucks being part of a platoon will have a different aerodynamic performance which may require an update of the existing regulation in order to take into account this reality.



## 7. TOPICS UNDER DISCUSSION

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In this chapter, an analysis of the main topics to be discussed in the working groups in the scope of the UNECE will be shown. These discussion topics will be monitored along the project since their feedback can be crucial for the development of platooning regulatory framework,

### 7.1. GRs analysis

As explained in chapter 5, in the scope of UNECE there are two working parties in charge of road safety (WP.1) and the harmonisation of the Vehicle Regulations (WP.29). Both bodies are working in creating the legislation needed to bring into the market new automated vehicle technologies. Among all these new technologies, the platooning technologies should be included. This is the topic of this work. See next paragraphs.

#### 7.1.1. Harmonization of Vehicle Regulations (WP.29) UNECE

As explained previously (Chapter 5), inside the Inland Transport Committee (in the scope of the Transport Division of UNECE) there is a working party dedicated to the world harmonization of the vehicle regulations. As this is one of the main aspects, together with the road legislation and the driver authorization, to manage in the scope of this work, the analysis of the topics under discussion will start from this Working Party and its subsidiary working groups.

During March 2018 session of the WP.29, there was a discussion about the convenience of changing the existing structure of the UNECE bodies in order to adapt the groups to the new automated vehicle technologies. It was thought that the arrangement of the groups was segmented into the different vehicle disciplines and the new automated vehicle technologies were not susceptible to be set into only one of the existing working groups.

Due to this motivation WP.29 in its next session (June 2018) agreed to convert the GRRF working group into a new working group named GRVA (*Groupe Rapporteurs Vehicule Autonome*). In order to do this change, some of the topics covered inside the old GRRF were allocated to other GR's. In this way, all regulations related with tyres were moved to the GRB (*Groupe Rapporteurs Bruit*) which from this moment was named as GRBP (*Groupe Rapporteurs Bruit et Pneumatiques*) "Working group on Noise and tyres". In addition, regulations about coupling devices were assigned to the GRSG and finally activities tank safety-related were allocated to GRSP.

Additionally, all the working sub-groups related with autonomous driving were moved under the scope of the new GRVA working group.

### *GRRF – GRVA: Latest news from GRRF*

The fast evolution of automated driving technologies and the necessity to regulate vehicles equipped with these technologies already in the market triggered a lot of activity in the group and its sub-working groups within the last two years (2017 & 2018).

On March 2018 WP.29 adopted a series of amendments to the UN Regulation No. 79 including the requirements for first ADAS systems (Remote Control Parking, Corrective Steering Function and Lane Keeping Assistance). In this amendment different categories for Automatically Controlled Steering Function were defined, in which ADAS functionalities can be fitted. For instance, RCP has to fulfil requirements for Category A and Lane Keeping Assistance (hands-on) is a Category B1 with regards with these definitions.

The development of the amendments for UN Regulation No. 79 is in charge of the Informal Working Group ACSF, which was created with the aim to modify Regulation 79. This is in line with the adaption of the regulation to the ADAS technologies. After the endorsement of the requirements of ACSF categories A and B1, this working group was working on the development of the prescriptions for the ACSF Cat. C (Lane Change Assist Systems). This modification was endorsed in a GRRF special session on December 2017

It was also detected the need for a regulation regarding the installation of the AEBS (Advanced Emergency Braking Systems) on M1 and N1 vehicle categories. A UN Regulation for AEBS already existed, but M1 and N1 categories are not included in the scope of this regulation. On March 2017 a new IWG started up to work on this matter.

Later, on February 2018, during the GRRF meeting the creation of a new regulation for AEBS M1 & N1 was indorsed. The GRVA meeting in September 2018 showed the first drafts of the new regulation.

Additionally, the GRVA February session presented a proposal in order to modify the requirements and tests of UN Regulation No. 131 (AEBS on commercial vehicles). One of the main points of this proposal is to perform more tests at different speeds instead to perform only test at 80 km/h, as in the present regulation. There was also an interesting discussion about the convenience of a disconnection button for the AEBS.

Table 23 shows a summary of all the meetings and their relevant outputs.



Evolution and remarkable decisions of the GRRF/GRVA Working Party	
<b>Jan 19</b>	<ul style="list-style-type: none"> <li>- Second session of GRVA. The objective is to introduce the highlights of the November 2018 session of the WP.29 and continue working on the same technical items of the first session.</li> </ul>
<b>Sep 18</b>	<ul style="list-style-type: none"> <li>- First session of GRVA. In this meeting there were important exchange of views on vehicle automation related work priorities and technology performance, from different member states and associations. The covered topics like: <ul style="list-style-type: none"> <li>o Framework regulation on AD</li> <li>o Track/ Real World Driving Evaluation</li> <li>o Simulation/ Virtual/ Automated assessment</li> <li>o Longitudinal control</li> <li>o Transition demand</li> <li>o Driver availability Recognition</li> <li>o Information to the driver HMI</li> <li>o Electronic System Compliance</li> <li>o PTI provisions</li> <li>o Cyber Security</li> <li>o Software updates including Over-the-Air</li> <li>o Etc.</li> </ul> </li> </ul> <p>In addition, the agenda included technical items discussions regarding regulations like UN Regulation Nos. 13, 13-H, 139, 140, 78, 79, 89 and 90.</p> <p>In this meeting, some stakeholders like the Russian Federation [12] or OICA [13] expressed their intention to introduce Platooning as a new regulatory topic to consider in the next years.</p>
<b>Jun 18</b>	<ul style="list-style-type: none"> <li>- WP.29 decided to convert the GRRF Working Party in the GRVA Working</li> </ul>
<b>Mar 18</b>	<ul style="list-style-type: none"> <li>- Adoption of the 2nd ACSF package with provisions for ACSF of Category C (Automated lane change manoeuvring initiated by the driver)</li> <li>- Discussion of the WP.29 restructuring in order to create a group dealing with vehicle automation</li> </ul>
<b>Feb 18</b> <b>GRRF' last meeting</b>	<ul style="list-style-type: none"> <li>- Resources management of the activities related to Automatically Commanded Steering Functions (ACSF)</li> <li>- 1st presentation of Remote Control Manoeuvring (RCM) draft provisions</li> <li>- Discussion of provisions for the automatic activation of AEBS systems</li> </ul>
<b>Dec 17</b>	<ul style="list-style-type: none"> <li>- Completion of the drafting of provisions for the type approval of: <ul style="list-style-type: none"> <li>o ACSF of Category C (Automated Lane Change initiated by the driver)</li> <li>o Emergency Steering Functions (ESF)</li> </ul> </li> <li>- Updates to Annex 6 (CEL)</li> </ul>
<b>Nov 17</b>	<ul style="list-style-type: none"> <li>- Endorsement of the revised ToR of the IWGs on ACSF and AEBS</li> <li>- Presentations by OICA and Catapult (UK) on "horizontal regulation" for HAD</li> <li>- Decision to establish an IWG on AD</li> </ul>



<b>Sep 17</b>	<ul style="list-style-type: none"> <li>- Discussion on automatic reactivation of AEBS</li> <li>- Adoption of the revised ToR of the IWG on ACSF - discussion of WP.29-172-08</li> <li>- Combined session WP.1 - WP.29/GRRF (secondary tasks, cyber security)</li> </ul>
<b>Jun 17</b>	<ul style="list-style-type: none"> <li>- Adoption by WP.29/AC.1 adopted all amendment proposals proposed by GRRF</li> <li>- WP.29 referred WP.29-172-08 to GRRF and asked GRRF to develop its roadmap to address SAE Level 3 and 4 technologies</li> <li>- Announcement of a Task Force (TF) on the testing of AD</li> </ul>
<b>Mar 17</b>	<ul style="list-style-type: none"> <li>- Adoption of the first ACSF package (incl. RCP, Lane keeping "hands on")</li> <li>- Endorsement of the (re)establishment of the IWG on AEBS - M1&amp;N1</li> <li>- First report from the TF on Cyber Security /OTA - Adoption of guidelines for CS and Data protection</li> <li>- Decision to regulate SAE Levels 3 and 4</li> </ul>

Table 23. Latest news from GRRF [14]

### 7.1.2. Global Forum for Road Traffic Safety (WP.1) UNECE

Within the scope of UNECE, there is also a working party dealing with the road traffic safety, which is the responsible of the Convention of Road Traffic of 1968 (also known as Vienna Convention). This document established the viewpoint that the driver must always be in full control of the vehicle. This was an impediment for the development of the autonomous driving technologies avoiding the autonomous driving on the roads. On March 2016, an amendment of the Vienna Convention modified the articles that were not compatible with automated driving technologies.

There is a consensus between WP.1 & WP.29 that both working parties should work together on the development of some of the regulations for autonomous driving. In this context, a shared meeting with WP.1 and GRRF members was held on September 2017. In this meeting, main discussions were about “secondary activities” and cyber-security. There was an agreement about the meeting’s construction. Chairs of both WP1 and GRRF agreed on working together in the next future.

Informal groups, Depending on the working parties mentioned above, there are informal working groups in order to deal with more specific topics like modification of UN Regulation No. 79 or Cyber-Security.





## 7.2. Tasks Forces and Informal documents

### 7.2.1. IWG ACSF (Automatically Commanded Steering Function)

This working group was born under the mandate of the GRRF, however after June 2018 when WP.29 renewed its working group structure, this IWG became part of the new GRVA.

The main mandate for this group was the modification of the UN Regulation No. 79 in order to regulate automated driving technologies which, up to this moment, were not allowed on this Regulation. This working group created a classification of the ACSF systems in order to create different requirements depending on the function. This is the classification and definition of each of the categories:

- "ACSF of **Category A**" means a function that operates at a speed no greater than 10 km/h to assist the driver, on demand, in low speed or parking manoeuvring.
- "ACSF of **Category B1**" means a function which assists the driver in keeping the vehicle within the chosen lane, by influencing the lateral movement of the vehicle.
- "ACSF of **Category B2**" means a function which is initiated / activated by the driver and which keeps the vehicle within its lane by influencing the lateral movement of the vehicle for extended periods without further driver command/confirmation.
- "ACSF of **Category C**" means, a function which is initiated / activated by the driver and which can perform a single lateral manoeuvre (e.g. lane change) when commanded by the driver.
- "ACSF of **Category D**" means a function which is initiated / activated by the driver and which can indicate the possibility of a single lateral manoeuvre (e.g. lane change) but performs that function only following a confirmation by the driver.
- "ACSF of **Category E**" means a function which is initiated / activated by the driver and which can continuously determine the possibility of a manoeuvre (e.g. lane change) and complete these manoeuvres for extended periods without further driver command/confirmation.

As said before, this group issued in 2017 and 2018 the series of amendments 02 and 03 of the UN Regulation No. 79 in order to include requirements and tests for Categories A, B1 and C.

The group is currently working on a proposal for category B2 systems (LKAS hands-off), which is an important step on the legislation, because it's the first regulatory text for a SAE Level 3 function.

In fact, the first session of GRVA agreed that requirements for B2 and successive categories were included into a new regulation. So, next meetings of the working group will be focused on the development of a new regulation for ALKS (Automated Lane Keeping System).



### 7.2.2. VMAD IWG (Validation Method for Automated Vehicles)

This informal working group was born under the auspices of the WP.29. At that moment it was named *AutoVeh*, with the aim to define a testing protocol for vehicles equipped with new autonomous technologies. The progress on these technologies is increasing very fast and the present way to approve vehicles could not be enough to guarantee the current safety level.

The number of complex electronic functions on the vehicle is increasing year by year and all these functionalities operate on an infinite amount of scenarios. This is a non-viable situation for manufacturers and technical services that will not be able to verify all the possible scenarios by means of the conventional tests in proving ground.

First session of this IWG was held in March 2018. It was decided to create two task forces: one dedicated to real certification tests and audits and the other task force dedicated to real world tests. In June, with the modification on the WP.29 working group structure this group was renamed to VMAD (*Validation Method for Automated Driving*) and re-allocated under the scope of the GRVA, it will host the same task forces.

VMAD and its task forces will consider the following items with the aim to assess the safety of driving performance in highway, interurban and urban environments:

- Testing in proving grounds
- Audits of manufacturer processes
- Simulation and virtual testing
- Testing under real-world conditions

### 7.2.3. UN Task Force on Cyber Security and update Over The Air (TF CS/OTA)

The Task Force on CS and OTA updates was developed as an informal group under the scope of the IWG ITS/AD with the goal of defining relevant issues for automotive industry with regards to Cyber Security and updates Over-The-Air. It was created at the end of 2016. In June 2018, it was reallocated under the scope of the GRVA. Finally the TF issued its final output at the 1<sup>st</sup> session of GRVA (September 2018)

The TF has developed two main documents: one recommendation for Cyber Security including the draft of a CS Regulation and another recommendation for OTA updates. It includes a draft of a future Regulation and also a regulatory text defining the RxSWIN “Regulation X Software Identification Number”.

The group asked to the GRVA about the possibility to extend the mandate of the Task Force for one year in order to test the content of both recommendations among some manufacturers, approval authorities and technical services.



#### **7.2.4. Informal documents GRE-79-36 and GRVA-01-06**

From 2016 GTB (International Automotive Lighting and Light Signalling Expert Group) is working in the necessities of special light signalling for automated vehicles, for indicating their status and the intended actions of the vehicle. On February 2018 the group held a meeting to deal with this issue. Later, they presented to the GRE the document GRE-79-36 exposing the outputs and conclusions of the meeting.

The group agreed that some basic signals should be mandatory for automated vehicles and it is necessary to develop a regulatory framework for this signalling before each vehicle manufacturer initiates their own signalling system. Therefore, the group decided to lead an initiative under the scope of the WP.29 for developing a regulation regarding the lighting and signalling system on automated vehicles. With this aim, they presented the informal document GRE-79-36 on April 2018 with the main outputs and conclusions of the meeting.

During the September session of GRVA, GTB also presented the informal document GRVA-01-06. The group expresses its will to participate and to share the expertise learned during these years. It will become a future informal working group for signalling on ACV.

## 8. SUMMARY AND CONCLUSION

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This report responds to the Subtask 6.3.1 EU regulatory framework on Truck Platooning. It represents the state of the art of the regulatory framework for ENSEMBLE project.

Firstly, this document reviews the background information from other relevant projects and initiatives. The main projects that have played an important role in the platooning era are: COMPANION (Cooperative dynamic formation of platoons for safe and energy-optimized goods transportation) and CARTRE (Coordination of Automated Road Transport Deployment for Europe). Both projects have brought relevant conclusions for the development and deployment of platoons in Europe. COMPANION has set the basic know-how and technology of platoons through a “one brand” platooning demonstration and CARTRE has analysed the needs at short and long term in order to enable the deployment of highly automated vehicles.

Another relevant initiative for the promotion of platooning is the ETPC European Truck Platooning Challenge 2016. Thanks to their cross-border platooning experiment, several lessons have been summarized [16] and learned. Their results and conclusions are also exposed in this report and will be considered for the correct development of the project.

Secondly, this deliverable provides a description of the structure of the regulatory bodies (mainly UNECE and EC) and its main players, the discussion groups. An important step before talking about regulations is to understand who the stakeholders are and how the rule-making works at an international level. It has to be taken into account that at the end of the project, recommendations to the regulatory framework will have to be given in order to allow platoons to become a reality.

After that, the Regulatory Matrix is presented in order to provide a classification of all regulations, directives and standards that might need a revision or modification to make the type-approve of platoons possible. This matrix has been shared with all OEMs in order to align ideas and concepts, and to detect possible missing items or gaps. Some of the regulations have been followed by some explicative lines below the matrix, in order to better understand why they have been selected and why their evolution will be closely followed along the project.

Finally, there are several topics that are being discussed nowadays in the UNECE WP29 sessions. These topics prove to be very relevant for the project development. Examples of these topics under discussion are the new series of amendments for UN Regulation No. 79 (which could introduce for instance category B2 systems such as the LKAS hands-off), the future testing protocol for vehicles equipped with new autonomous technologies which is being discussed at the VMAD Working Group or the forthcoming regulations for Cyber Security, Over-The-Air updates or Software Identification Number.



ENSEMBLE is a three-year project finishing in 2021, thus the follow-up of these discussions are crucial for the performance of Task 6.3 Regulatory framework evolution for platooning. Furthermore, in the next steps, a gap analysis linking WP2 requirements and specifications and regulations will also be necessary and crucial for the development of the project.

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## APPENDIX A: GLOSSARY

### Definitions of terms used in ENSEMBLE

Term	Definition
Platoon	A group of two or more automated cooperative vehicles in line, maintaining a close distance, typically such a distance to reduce fuel consumption by air drag, increase traffic safety by use of additional ADAS-technology, and improve traffic throughput because vehicles are driving closer together and taking up less space on the road.
Platoon Automation Levels	In analogy with the SAE automation levels subsequent platoon automation levels will incorporate an increasing set of automation functionalities, up to and including full vehicle automation in a multi-brand platoon in real traffic for the highest Platooning Automation Level. The definition of “platooning levels of automation” will comprise elements like e.g. the minimum time gap between the vehicles, whether there is lateral automation available, driving speed range, operational areas like motorways, etc. Three different levels are anticipated; called A, B and C.
Requirements	Description of system properties. Details of how the requirements shall be implemented at system level
Specifications	A group of two or more vehicles driving together in the same direction, not necessarily at short inter-vehicle distances and not necessarily using advanced driver assistance systems
Convoy	A truck platoon may be defined as trucks that travel together in convoy formation at a fixed gap distance typically less than 1 second apart up to 0.3 seconds. The vehicles closely follow each other using wireless vehicle-to-vehicle (V2V) communication and advanced driver assistance systems
Truck Platoon	Description of system properties. Details of how the requirements shall be implemented at system level
Scenario	A scenario is a quantitative description of the ego vehicle, its activities and/or goals, its static environment, and its dynamic environment. From the perspective of the ego vehicle, a scenario contains all relevant events. Scenario is a combination of a maneuver (“activity”), ODD and events
Manoeuvre (“activity”)	A particular (dynamic) behaviour which a system can perform (from a driver or other road user perspective) and that is different from standing still, is being



	considered a manoeuvre.
ODD (operational design domain)	The ODD should describe the specific conditions under which a given automation function is intended to function. The ODD is the definition of where (such as what roadway types and speeds) and when (under what conditions, such as day/night, weather limits, etc.) an automation function is designed to operate.
Event	An event marks the time instant at which a transition of a state occurs, such that before and after an event, the system is in a different mode.
Use case	<p>Use-cases describe how a system shall respond under various conditions to interactions from the user of the system or surroundings, e.g. other traffic participants or road conditions. The user is called actor on the system, and is often but not always a human being. In addition, the use-case describes the response of the system towards other traffic participants or environmental conditions. The use-cases are described as a sequence of actions, and the system shall behave according to the specified use-cases. The use-case often represents a desired behaviour or outcome.</p> <p>In the ensemble context a use case is an extension of scenario which add more information regarding specific internal system interactions, specific interactions with the actors (e.g. driver, I2V) and will add different flows (normal &amp; alternative e.g. successful and failed in relation to activation of the system / system elements).</p>
Operational layer	The operational layer involves the vehicle actuator control (e.g. accelerating/braking, steering), the execution of the aforementioned manoeuvres, and the control of the individual vehicles in the platoon to automatically perform the platooning task. Here, the main control task is to regulate the inter-vehicle distance or velocity and, depending on the Platooning Level, the lateral position relative to the lane or to the preceding vehicle. Key performance requirements for this layer are vehicle following behaviour and (longitudinal and lateral) string stability of the platoon, where the latter is a necessary requirement to achieve a stable traffic flow and to achieve scalability with respect to platoon length, and the short-range wireless inter-vehicle communication is the key enabling technology.
Tactical layer	The tactical layer coordinates the actual platoon forming (both from the tail of the platoon and through merging in the platoon) and platoon dissolution. In addition, this layer ensures platoon cohesion on hilly roads, and sets the desired platoon velocity, inter-vehicle distances (e.g. to prevent damaging bridges) and lateral offsets to mitigate road wear. This is implemented through the execution of an interaction protocol using the short-range wireless



	inter-vehicle communication (i.e. V2X). In fact, the interaction protocol is implemented by message sequences, initiating the manoeuvres that are necessary to form a platoon, to merge into it, or to dissolve it, also taking into account scheduling requirements due to vehicle compatibility.
Strategic layer	The strategic layer is responsible for the high-level decision-making regarding the scheduling of platoons based on vehicle compatibility and Platooning Level, optimisation with respect to fuel consumption, travel times, destination, and impact on highway traffic flow and infrastructure, employing cooperative ITS cloud-based solutions. In addition, the routing of vehicles to allow for platoon forming is included in this layer. The strategic layer is implemented in a centralised fashion in so-called traffic control centres. Long-range wireless communication by existing cellular technology is used between a traffic control centre and vehicles/platoons and their drivers.
Service layer	The service layer represents the platform on which logistical operations and new initiatives can operate.
Leading truck	The first truck of a truck platoon
Following truck	Each truck that is following behind a member of the platoon, being every truck except the leading and the trailing truck, when the system is in platoon mode.
Trailing truck	The last truck of a truck platoon
Ego Vehicle	The vehicle from which the perspective is considered.
Platoon cohesion	Platoon cohesion refers to how well the members of the platoon remain within steady state conditions in various scenario conditions (e.g. slopes, speed changes).
Platoon formation	Platoon formation is the process before platoon engaging in which it is determined if and in what format (e.g. composition) trucks can/should become part of a new / existing platoon. Platoon formation can be done on the fly, scheduled or a mixture of both. Platoon candidates may receive instructions during platoon formation (e.g. to adapt their velocity, to park at a certain location) to allow the start of the engaging procedure of the platoon.
Platoon engaging	Using wireless communication (V2V), the Platoon Candidate sends an engaging request. When conditions are met the system starts to decrease the time gap between the trucks to the platooning time gap. A.k.a. join platoon
Platoon disengaging	The ego-vehicle decides to disengage from the platoon itself or is requested by another member of the platoon to do so. When conditions are met the ego-vehicle starts to increase the gap between the trucks to a safe non-platooning gap. The disengaging is completed when the gap





	is large enough (e.g. time gap of 1.5 seconds, which is depends on the operational safety based on vehicle dynamics and human reaction times is given). A.k.a. leave platoon
Platoon dissolve	All trucks are disengaging the platoon at the same time. A.k.a. decoupling, a.k.a. disassemble.
Platoon split	The platoon is split in 2 new platoons who themselves continue as standalone entities.
Emergency brake	Brake action with an acceleration of $<-4 \text{ m/s}^2$
Cut-in	A lane change manoeuvre performed by vehicles from the adjacent lane to the ego vehicle's lane, at a distance close enough (i.e., shorter than desired inter vehicle distance) relative to the ego vehicle.
Cut-out	A lane change manoeuvre performed by vehicles from the ego lane to the adjacent lane.
Cut-through	A lane change manoeuvre performed by vehicles from the adjacent lane (e.g. left lane) to ego vehicle's lane, followed by a lane change manoeuvre to the other adjacent lane (e.g. right lane).
Steady state	In systems theory, a system or a process is in a steady state if the variables (called state variables) which define the behaviour of the system or the process are unchanging in time. In the context of platooning this means that the relative velocity and gap between trucks is unchanging within tolerances from the system parameters.
Platoon candidate	A truck who intends to engage the platoon either from the front or the back of the platoon.
Time gap	Elapsed time to cover the inter vehicle distance by a truck indicated in seconds.

### Acronyms and abbreviations used in ENSEMBLE

Acronym / Abbreviation	Meaning
ABS	Anti-lock Braking System
ACC	Adaptive Cruise Control
ACSF	Automatically Commanded Steering Function



ADAS	Advanced driver assistance system
ADR	Agreement concerning the International Carriage of Dangerous Goods by Road
AEB	Automatic Emergency Braking (System, AEBS)
ASIL	Automotive Safety Integrity Level
ASN.1	Abstract Syntax Notation One
BTP	Basic Transport Protocol
C-ACC	Cooperative Adaptive Cruise Control
C-ITS	Cooperative ITS
CA	Cooperative Awareness
CAD	Connected Automated Driving
CAM	Cooperative Awareness Message
CCH	Control Channel
CS	Cyber Security
CSF	Corrective steering functions
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
DSRC	Dedicated Short-Range Communications
EC	European Commission
EMC	Electromagnetic Compatibility
ESF	Emergency steering function
ESP	Electronic Stability Program
ETSI	European Telecommunications Standards Institute
EU	European Union
FAD	Fully Automated Driving
FCW	Forward Collision Warning
FLC	Forward Looking Camera
FSC	Functional Safety Concept
GN	GeoNetworking

GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRVA	Working Party on Automated/Autonomous and Connected Vehicles
HAD	Highly Automated Driving
HARA	Hazard Analysis and Risk Assessment
HIL	Hardware-in-the-Loop
HMI	Human Machine Interface
HW	Hardware
I/O	Input/Output
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITC	Inland Transport Committee
ITS	Intelligent Transport System
IVI	Infrastructure to Vehicle Information message
LDWS	Lane Departure Warning System
LKA	Lane Keeping Assist
LCA	Lane Centering Assist
LRR	Long Range Radar
MAP	MapData message
MRR	Mid Range Radar
MVC	Modular Vehicle Combinations
OBD	On-Board Diagnostics
OS	Operating system
ODD	Operational Design Domain
OEM	Original Equipment Manufacturer
OTA	Over the air
PAEB	Platooning Autonomous Emergency Braking
PMC	Platooning Mode Control



QM	Quality Management
RCP	Remote Control Parking
RSU	Road Side Unit
SAE	SAE International, formerly the Society of Automotive Engineers
SCH	Service Channel
SDO	Standard Developing Organisations
SIL	Software-in-the-Loop
SPAT	Signal Phase and Timing message
SRR	Short Range Radar
SW	Software
TF	Task Force
UNECE	United Nations Economical Commission of Europe
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to any (where x equals either vehicle or infrastructure)
VDA	Verband der Automobilindustrie (German Association of the Automotive Industry)
VECTO	Vehicle Energy Consumption Calculation Tool
VMAD	Validation Method for Automated Driving
WIFI	Wireless Fidelity
WP	Work Package
WP.1	Working Party 1 - Global Forum for Road Traffic Safety
WP.29	Working Party 29 - World Forum for Harmonization of Vehicle Regulations