
# Aerodynamic and Flexible Trucks for Next Generation of Long-Distance Road Transport

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# Publishable Executive Summary

The aim of this document is to deliver a handbook of requirements and recommendations for the implementation of aerodynamic and flexible trucks for freight and logistics in a multi-modal context which will serve as a guide to policy makers to define future legislations and standards. This report (D7.2 *Book of Recommendation. Models validation and future regulatory framework proposals)* represents the second deliverable of Work Package 7 named *Recommendations and roadmap for a new regulatory framework*. The present report has been divided in three parts which are summarised below:

**PART A: Methodology and process**

This part of the document describes the main activities that have been performed during the project in order to obtain the conclusions and recommendations that are summarised in this deliverable. Part A has two chapters:

- **Chapter 1 – Regulatory Framework state of the art and open discussions**
  The aim of Chapter 1 is to provide an update of the discussions and initiatives that are being carried out by the regulatory bodies. There are two organisations that play a key role in regulations making: The United Nations Economic Commissions for Europe (UNECE) and the European Commission (EC). Both have similar structures and mechanisms; they are divided into discussion groups which are again divided into topics of interest. The goal of the analysis developed within the project has been to identify which discussion/experts' groups have a direct relation to AEROFLEX solutions.
- **Chapter 2 – Sounding board activity**
  The Sounding Board is a group of experts that have been involved since the beginning of the project and that have actively participated in it through several meetings and workshops. These workshops and meetings have been focused in developing, validating and consolidating the concepts that have settled up the base of the conclusions and future recommendations included in Part B and Part C of this document.

**PART B: Future recommendations at vehicle level**

The aim of this part is to provide recommendations for the update of the vehicle type approval regulatory framework in order to allow the future implementation and deployment of the AEROFLEX innovations and solutions in the market. Part B contains the study and analysis of the technologies that have been implemented in the AEROFLEX project and, therefore, is divided in four main sections:

1. Advanced Energy Management Powertrain (AEMPT)
2. Aerodynamic Features for the Complete Vehicle (AFCV)
3. Smart loading units (SML)
4. Innovative Front End Design for more Safety (IFEDS)

Each section of this part is related to one solution/concept and, for each one of them, a description of the regulations and the recommendations to update them, so that they allow the introduction of these solutions, are given.

**PART C: Future recommendations on Access to infrastructure**

The vision of AEROFLEX is to support the vehicle manufacturers to achieve the coming challenges for road transport. While the type approval of the vehicles is important, during the development of this project it has been crucial to have a holistic vision of the whole multimodal transport process. With this aim in mind, it was identified that Intelligent Access Policies (IAP) would act as key enablers to allow access of new types of vehicles (like the AEROFLEX's ones).

Part C of the deliverable defines the recommendations and the next steps towards the deployment of Intelligent Access Policies at European Level. In order to do so, it summarised the activities done in Europe and beyond (link to Australia) and establishes the fundamentals of Intelligent Access Policies (IAP).

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# Purpose of the document

This document is the *AEROFLEX D7.2 Book or Recommendation. Models validation and future regulatory framework proposals* and it is the second deliverable of *Work Package 7 – Recommendations and roadmap for a new regulatory framework*.

This main goal of this deliverable is to provide a "Handbook of requirements and recommendations for the implementation of aerodynamic and flexible trucks for freight and logistics in a multi-modal context" which is expected to serve as a guide to policy makers to define future legislations and standards.

This deliverable is the result of Task 7.5 *Future regulatory framework proposals* and it can be considered the final step to conclude the work done during the whole AEROFLEX project as it will take into account all the innovative aspects of future configurable trucks developed by WP2, WP3, WP4 and WP5. In addition, the outcomes of WP1's and WP6's final assessment will be taken into account for the development of the recommendations on how to incorporate complex vehicle configurations as an extension to existing homologation and certification methods and procedures for pollutant and greenhouse gas emissions.

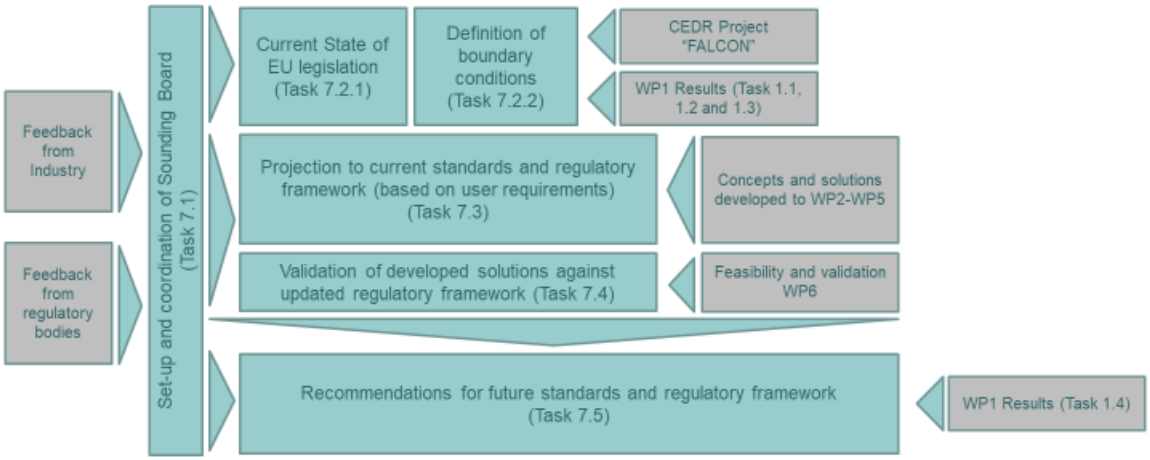


**Figure 1. Work Package 7 activities and interactions**

This document has been arranged in three parts in order to guide the reader through the document:

- Part A: Methodology and process
  The main goal of Part A is to summarize the outcomes of the Sounding Board workshops held during the development of the project. In total, 13 meetings have been organized including thematic workshops focused on logistics, regulations and intelligent access policies.

  In addition, Part A provides an insight on which are the main bodies involved in the policy making procedure. An update on the information previously given in Deliverable 7.1 can be found in this part, which makes an in depth analysis on the working groups, discussions and initiatives that are being carried out by the regulatory bodies. The main goal is to provide the reader the necessary input to understand how the policy making works and which outcomes from the different regulatory forums and discussion groups are useful for AEROFLEX project.

- Part B: Future recommendations at vehicle level
  In this part of the deliverable the reader can find the final recommendations that are proposed related to the type approval of the vehicles. It analyses which updates on the regulatory framework would be needed in order to introduce in the market the different technologies and solutions that have been developed within the project by each WP.

- Part C: Future recommendations on access to infrastructure
  The aim of this part is to explain the need of introducing Intelligent Access Policies (IAP) to the infrastructure for heavy duty vehicles. Part C explains the fundamentals of IAP and identifies a number of stakeholder clusters which are seen crucial for their adoption; it summarises their needs and the steps towards deployment of IAP. The recommendations are presented with a specific vision on how the IAP can be implemented in Europe to substantially enhance road freight transport efficiency.

# PART A: Methodology and process

# Methodology and process

This part of the document (Part A) summarises the activities that have been performed during the whole development of the project which have contributed to the conclusions and recommendations obtained in this deliverable. The two main activities done during the project have been the analysis and monitorization of the regulatory framework discussion forums and the organisation of workshops and meetings with the sounding board members. Therefore, Part A contains two main chapters:

- **Chapter 1 – Regulatory Framework state of the art and open discussions**

  In this chapter, a follow-up on AEROFLEX's deliverable D7.1 is made. In order to provide adequate and up to date recommendations for the adaptation of the current regulatory framework in order to include the solutions and technologies developed within the project, it is needed to follow-up on the discussions and initiatives that are being carried out by the regulatory bodies. This research has been conducted throughout the project and its results are summarised in Chapter 1.

- **Chapter 2 – Sounding board activity**

  The Sounding Board is a group of experts that have been involved since the beginning of the project and that have actively participated in it through several meetings and workshops. Their contribution has been very valuable as it has allowed create a common view and validate the outcomes of this Book of recommendations. Chapter 2 summarises the outcomes of the Sounding Board workshops held since September 2019 as the information from previous workshops can be found in deliverable D7.1.

# 1 Regulatory Framework state of the art and open discussions

This chapter focuses on updating the current state of the discussions and initiatives being held by the main regulatory bodies. An introduction to understanding the policy making procedure and its main bodies and working groups can be found in previous deliverable D7.1, therefore, in case further information is needed, please refer to that deliverable.

## 1.1 UNECE level

The Inland Transport Committee (ITC) is the UN platform for inland transport to help efficiently address global and regional needs in inland transport. Together with its subsidiary bodies, the Working Parties (WPs), the ITC has provided an intergovernmental forum, where UNECE and United Nations Member States come together to forge tools for economic cooperation and negotiate and adopt international legal instruments on inland transport.

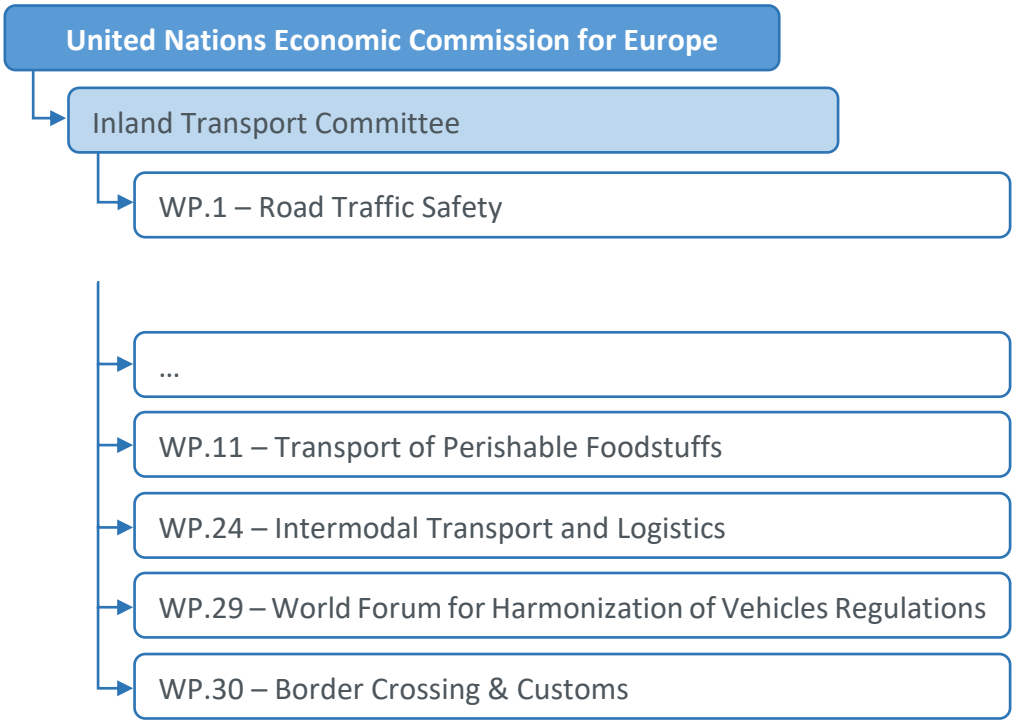


**Figure 2. Inland Transport Committee's structure**

During the development of the project it has been noticed that it would be interesting to follow up additional working parties, besides the one identified in the previous deliverable D7.1, as their scope could include topics related to the AEROFLEX project and the Intelligent Access Policies. Figure 2 shows the WP's identified that are introduced in this chapter and which its main outcomes from the latest sessions related to the project have been summarised.

### 1.1.1 WP.1 – Global Forum for Road Traffic Safety

The Working Party on Road Traffic Safety (WP.1) was established in 1988 and changed its name to "Global Forum for Road Traffic Safety" in 2017. The main objective of this Working Party is to improve road safety by harmonizing traffic rules and other legal instruments that address the main factors of road accidents.

With regards to vulnerable road users, the Working Party is developing policy making guidelines for Vulnerable Road Users for Conditions found in South, Southeast Asian and Other Countries of Transition Economies.

A new action plan of the WP.1 is the creation of a Group of Experts on drafting a new legal instrument on the use of automated vehicles in traffic. This legal instrument is expected to complement the 1949 and 1968 Conventions

on Road Traffic[1], and will include a set of provisions for the safety deployment of automated vehicles in international traffic.
The Group of Experts will have a two-year duration starting as of July 2021. The final document will be submitted to its supervising body, WP.1 for consideration and decision.

The participation to the group is limited to representatives officially nominated by the Governments of the Contracting Parties to the 1968 Convention on Road Traffic and those of the 1949 Convention. The representatives have professional experience in road safety, traffic law, and/or transport policy.

In 2019, a brochure resolution on the Deployment of Highly and Fully Automated Vehicles in Road Traffic[2] was presented by the group. The resolution is intended to guide the Contracting Parties with respect to the deployment of highly and fully automated vehicles in road traffic, in order to support the enhancement of road traffic safety, mobility and socio-economic progress. Additionally, the document will evolve as technology develops so the explicit inclusion of a recommendation is not constructed as an implicit exclusion of any other.

The recommendations are mainly addressed to three groups: Automated driving systems, users of automated driving systems and Governments. Some of these recommendations are summarised below.

- Automated driving systems should:
  a) Make road safety a priority.
  b) Comply with traffic rules.
  c) Be capable of achieving a state that maximizes road safety when a given trip cannot or should not be completed for example in cases of failure in the automated driving system or other vehicle system.
  d) React to unforeseen situations in a way that minimizes danger to the vehicle's users and other road users.

- Users of automated driving systems should:
  a) Be aware and informed of their proper use prior to starting the journey.
  b) Act lawfully at all times so as not to compromise road safety regardless of whether they or automated driving systems are exercising the dynamic control

- Governments should consider:
  a) Promoting public awareness and understanding of the safe use of highly and fully automated vehicles to help secure the potential safety, mobility and socioeconomic benefits.
  b) Adopting policies in accordance with their privacy regulations regarding the necessary data to assess.
  c) Incorporating recommendations of the resolution into their domestic legal policy framework for road traffic in a way that recognizes their national context.

### 1.1.2 WP.11 – Transport of Perishable Foodstuffs

The Working Party on the Transport of Perishable Foodstuffs (WP.11) was created in 1948. Its main goal was to determine which operating difficulties were faced by international traffic of perishable foodstuffs. Nowadays, the WP.11's goals are to develop and update the "Agreement concerning the International Carriage of Perishable Foodstuffs and on the Special Equipment to be Used for Such Carriage (ATP)" and to promote the facilitation of international transport of perishable foodstuffs by harmonizing the relevant regulations and rules and the administrative procedures and documentation requirements to which this refrigerated transport is subject.

In its session held in October 2019 the topics discussed were mainly focused on thermal units and refrigerating equipment. Some standards have been revised with regards the testing of thermal containers and transportation

[1] https://unece.org/sites/default/files/2020-12/ECE-TRANS-2021-6e.pdf

[2] https://unece.org/DAM/trans/main/wp1/wp1doc/WP1_Resolution_Brochure_EN_web.pdf

of sensitive goods. In addition, after revision of the amendments proposed regarding the testing of the refrigerating equipment, a new version of the Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be Used for such Carriage (ATP) has been released and is valid from July 2020.

### 1.1.3 WP.15 – Transport of Dangerous Goods

The Working Party on the Transport of Dangerous Goods typically meets twice a year in order to ensure consistency between all the regulatory systems that involve dangerous goods which are subject to transport, workplace, storage, consumer and environment protection regulations so as to prevent accidents to persons, property or the environment. In order to do so, the United Nations has developed mechanisms for the harmonization of hazard classification criteria and communication tools, and for transport conditions for all modes of transport.

At the meeting held in November 2019, the working party proposed different options to clarify provisions concerning the passage of vehicles carrying containers loaded with dangerous goods in limited quantities through tunnels.

### 1.1.4 WP.24 – Intermodal Transport and Logistics

Since 1951, the Working Party on Intermodal Transport and Logistics, initially called Working Party on Containers, has provided a forum for the exchange of technical, legal and policy information, as well as best practices, in combined and intermodal transport with the aim of promoting this way of transportation. It meets twice a year in Geneva and has addressed topics in the areas of:

- Pan-European networks and service standards for combined transport (AGTC)
- Interregional Euro-Asian land transport links
- Efficient intermodal loading units
- Administration of the IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units (CTU Code)
- Safety in intermodal transport operations
- Liability provisions for intermodal transport
- Combined/intermodal transport terms
- National policy measures to promote intermodal transport
- Intermodal transport as part of modern transport chains and logistics

One of the topics that is being developed is an advanced draft version of the Europe (ECE) Handbook for national master plans for freight transport and logistics (Informal document No 2 – November 2019). This document discusses the role of the governments in freight transport and logistics regarding the creation of stable conditions for doing business, study of availability of infrastructure and in achieving high-level objectives. It is also intended to have a compilation of the good practices of the countries that are developing freight transports and logistics. The master plan includes information on intermodal terminals as it is considered that combined transport can be one way to optimization of the transport operation. However, this is only possible, if adequate infrastructure in terms of intermodal terminals is provided, where the mode change can be performed. With this objective, the AGTC and Protocol on Combined Transport on Inland Waterways to the AGTC define the locations of the combined transport terminals respectively on rail lines with the possibility to switch to road; and on waterways with possibilities to change to road and/or rail.

### 1.1.5 WP.29 – World Forum for Harmonization of Vehicle Regulations

This Working Party is the forum were safety and environmental aspects of the regulatory framework are being discussed. The objective of this forum is to allow an introduction to the market of innovative vehicle technologies while improving global vehicle safety, in addition, the regulatory framework also fosters the facilitation of cross-border trade.
It meets twice a year and the forum is divided in six permanent Working Parties (GRs), that perform specialized tasks. This subsidiary bodies are:

- Noise and Tyres (GRBP)
- Lighting and Light-Signalling (GRE)
- Pollution and Energy (GRPE)
- Automated and Connected Vehicles (GRVA)

- General Safety Provisions (GRSG)
- Passive Safety (GRSP).

Depending on the topic, the WP.29 also establishes time-limited Informal Working Groups (IGWs) in order to deal with certain technical issues.

#### 1.1.5.1 GRVA - Working Party on Automated/Autonomous and Connected Vehicles

As the automotive world is evolving fast, the need to create specific informal working groups to regulate this field has increased considerably. That is why from Deliverable 7.1 to the current Deliverable 7.2, within the GRVA, different changes have been seen in the Informal Working Groups. These modifications are focused mainly on the new ADAS system and their needs on Cyber Security and Software Updates. Therefore, the new informal working groups are ADAS, R157 and CS/OTA.

Other groups had some changes, specifically the AEBS group which started with a focus on categories $M_2$, $M_3$, $N_2$ and $N_3$ working on UN Regulation 131 and, after this regulation was released, the group updated to concentrate on $M_1$ and $N_1$ to complete the UN Regulation 152. The latest objective of this group is to introduce new requirements for vulnerable road users with respect to the AEBS of Heavy Duty Vehicles.

The current structure of GRVA can be seen in Figure 3.

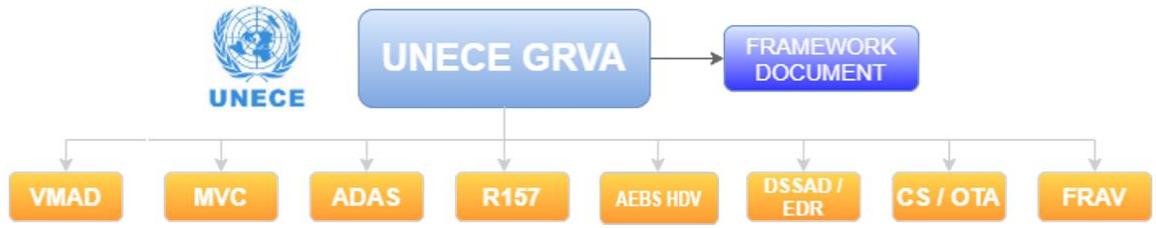


**Figure 3 GRVA's Informal Working Groups**

Below, further explanation on the different Informal Working Groups of the GRVA and their latest work is given.

- **Validation Method for Automated Driving (VMAD)**

VMAD's objective is to develop an assessment method capable of validating the safety of automated systems based on a multi pillar approach. This new certification approach would include audits, simulations, virtual testing, test track and real-world testing. Conventional test methods are not able to evaluate all the challenges raised for automated driving, so there is a need to develop new assessment and test methods, not to replace the current testing but to complement it. Therefore, the VMAD group is developing a new certification approach based on three pillars that can be seen in Figure 4.


**Figure 4. New certification approach**

The first step of the new certification process starts with the audit of the development process. Analysis of the safety concept and functional safety has been performed on complex electronic systems within the classical certifications, but currently this evaluation is growing in importance, so it is necessary to standardize it. This first

pillar is not limited to an audit, as some simulations can be used as validation of the system during the development process.

Once the initial assessment has been done, next stage would match the results obtained with proving ground tests. On proving ground, special cases can be reproduced in order to evaluate the real behaviour of the vehicle, focusing on scenarios and conditions considered as "edge conditions". Finally, the behaviour of the system on public roads is evaluated trying to achieve a given set of situations to fill all the common situations.

Currently the method is being developed together with the new ALKS regulation (Automated Lane Keeping System). ALKS regulation will cover systems which are activated by the driver at low speeds and keeps the vehicle within its lane by influencing the lateral movement of the vehicle and controls the longitudinal movement of the vehicle for extended periods without further driver command. It is intended for passenger cars (M1 vehicles).
ALKS will be the first UN regulated system that will allow to the driver not to be in control of the vehicle.

- **ADAS**

In February 2021, the Terms of Reference of a new informal working group were adopted by the GRVA. The aim of the group is to focus in Advanced Driver Assistance Systems (ADAS) and shall address the simplification of UN Regulation 79 (steering systems).
The main idea is to develop a new ADAS UN regulation containing all the ADAS systems up to SAE level 2. Additionally, the group will address the following issues:

a) Outline the use-cases that are expected to be available for the market now and in the next years.
b) Consider the definition, classification and scope of functions of ADAS.
c) Ensure that use cases and functions are considered subject to a safety evaluation aimed at ensuring maintaining and if possible, improving the traffic safety.
d) Pay special attention to the shared driving task between the driver and the vehicle:
    a. HMI
    b. Human factor issues.
    c. Information of the user.

The group is highly active with more than one meeting per month (until September 2021), and has already presented a new draft Regulation for ADAS systems to the GRVA.[3]

- **Automatically Commanded Steering Function (ACSF)**

The ACSF prepared a draft for a UN Regulation on ALKS, this draft was submitted, on March 2020, to the WP.29 and the Administrative Committee of the 1958 Agreement (AC.1) for consideration. As a result, in the WP.29 session held on June 2020, the Regulation No 157 of Automated Lane Keeping System (ALKS) was adopted.
The final document includes:

1. Definitive version of the Annex 4 (about functional and operational safety of the ALKS) provided by the VMAD group.
2. Prescriptions about Cyber-Security and the Software Updates, these requirements are much related with new regulations on these topics.
3. Chapter with DSSAD (Data Storage System for Automated Driving) requirements. These prescriptions were provided by the informal working group in charge of drafting the future EDR/DSSAD Regulation.

- **UN Regulation 157: Automated Lane Keeping System**

The informal group of the Automated Lane Keeping System (ALKS) started in January 2021. This group was created due to the complexity and importance of this Regulation. The meetings are held every month due to the need to do continuous work to share all points of view.

The ALKS controls the lateral and longitudinal movement of the vehicle for extended periods without further driver command. ALKS is a system whereby the activated system is in primary control of the vehicle. This system can be activated under certain conditions on roads where pedestrians and cyclists are prohibited and which, by design,

[3] https://wiki.unece.org/display/trans/ADAS+-+7th+session

are equipped with a physical separation that divides the traffic moving in opposite directions and prevent traffic from cutting across the path of the vehicle.

At the beginning of the discussions, this system was defined to limited speed of 60 km/h and focused on category $M_1$. However, the last discussions went focused towards updating the limited speed to 130 km/h and change the category from $M_1$ to M and N.

- **Automated Emergency Braking System for Heavy Duty Vehicle (AEBS HDV)**

This informal group was created by the end of 2020, but it has held one meeting per month until May 2021. The high importance of this group is the need to include vulnerable road users (pedestrians and bicycles) to the scope of the autonomous emergency braking system of trucks and buses, UN Regulation No. 131.
The main idea of the group is to follow the same criteria used for the creation of UN Regulation 152 (AEBS for passenger cars), which includes tests not only for cars, but also for pedestrians and bicycles.

Additionally, tests procedures for AEB with other vehicles will also be revised in order to include more scenarios, because current approach of the Regulation only requires 2 tests at the same speed, while scenarios of Regulation 152 covers all the speed range of the system.

According to the terms of reference of the group, a first version of the amendment will be presented by the end of 2021, including new scenarios for vehicle to vehicle and pedestrians. As a second stage, bicycles will be added with new tests and provisions.

- **Data Storage System for Automated Driving / Event Data Recorder (DDSAD / EDR)**

This informal group is responsible of developing two proposals for new regulations on Event Data Recorder (both for conventional vehicles and autonomous) and Data Storage Systems for Automated Driving. EDR will collect data related to collisions, that will be valuable for accidents reconstructions.
DSSAD is going to collect data of the operational status of the automated/autonomous driving system and the driver during incidents.

- **Functional Requirements for Automated and Autonomous Vehicles (FRAV)**

The FRAV group is in charge of the development of functional requirements for automated/autonomous vehicles, in particular, the combination of different functions of driving: longitudinal control, lateral control, environment monitoring, minimum risk manoeuvre, transition demand, human machine interface and driver monitoring. It also takes into account the failsafe response in order to validate the system safety, that in so many cases is evaluated by the manufacturer during the development phase by implementing ISO 26262 for Functional Safety.

- **Task Force on Cyber Security and Software Updates (CS/OTA)**

With regards to the cyber security and software updates, in June 2019, on the 3rd session of the GRVA, the following subsidiary bodies were created:

- IWG on Functional Requirements for Automated Driving (FRAV)
- IWG on Validation Methods for Automated and Autonomous Vehicles (VMAD)
- Task Force on Cyber Security and Software Updates
- IWG on Data Storage Systems for Autonomous Driving and/or Event Data Recorder (DSSAD/EDR).

Once they were established, GRVA invited the Task Force on Cyber Security and Software updates to prepare the proposal for a new UN Regulation on cyber security. As a result, two new regulations were adopted in June 2020 by the World Forum for Harmonization of Vehicle Regulations (WP.29):

- **UN Regulation on Cyber security** - Regulation No 155 Cyber security and cyber security management system (ECE/TRANS/WP.29/2020/79 as amended by 2020/94 and 2020/97)
- **UN Regulation on Software updates** - Regulation No 156 Software update and software update management system (ECE/TRANS/WP.29/2020/80)

Granting cybersecurity of automated/autonomous vehicles is mandatory in terms of security for road users over the lifetime of the vehicle. For that reason, the proposed regulation establishes requirements for the Cyber Security Management System of the manufacturer, so as well as for the vehicle type. Starting from 2022, manufacturers for commercial vehicles and messenger cars (categories M, N and O) will have to address cyber security for they vehicles, identifying vulnerabilities and threats in order to assure the vehicle safety. Once threats are identified, a mitigation plan will be required to reduce them. All this process will be assessed with an audit and the analysis of the documentation.

- **Modular Vehicle Combination (MVC) Working Group of the GRVA**

During 2020, and part of 2021, the informal group on Modular Vehicle Combinations has met several times with the aim to introduce new amendments to Regulation 13 (braking system) and Regulation 55 (coupling devices). Regulation on braking systems until 2020, only covered, or was intended for, the type approval of vehicles involved in single trailers combinations. The regulation also took provisions on the compatibility between the tractor and the trailer, but only one combination was covered.

The first objective of the group was to add new definitions and requirements for the approval of single vehicles involved in modular combinations such as towing trailers, dollies and link trailers. It was an important step, because the inclusion of these provisions avoided the individual approval according to non-harmonized national requirements, which limits market competition and operation.

The amendment described above, regarding the inclusion of new vehicle definitions and their relevant requirements, was adopted at GRVA session of September 2020, but only covers dollies with rigid drawbars. These are the new three definitions created by the group, that allow new combinations:

*A "**towing trailer**" is a trailer which is equipped to tow another trailer.*

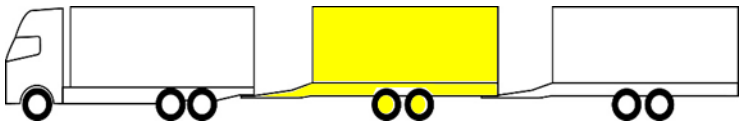

**Figure 5. Towing trailer illustration.**

*A "**Dolly**" is a towing trailer designed for the sole purpose to tow a semi-trailer. A dolly may have a rigid or a hinged drawbar.*

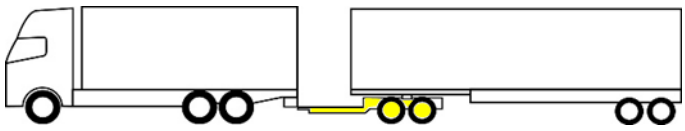

**Figure 6. Dolly illustration.**

*A "**Link-trailer**" is a semitrailer equipped with a fifth wheel in its rear end enabling a second semitrailer to be towed. (Definition from R55-01 supplement 7).*

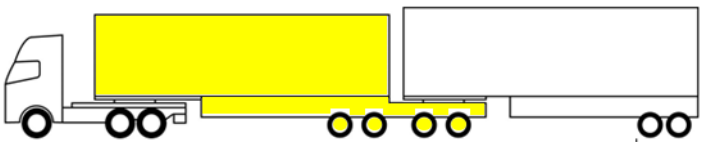

**Figure 7. Link Trailer illustration.**

These combinations defined in above pictures have been taken into account given that are the ones most used for the modular vehicle transport in Europe. The second step that has been elaborated by the group, is the inclusion of dollies with hinged drawbar and other combinations or types of vehicles to UN Regulation No. 13. In

addition, Regulation 79 (steering system) should also be revised to included steered dollies (one of the technologies included in the project), and Regulation 55.

#### 1.1.5.2 GRSG - Working Party on General Safety Provisions

The Working Party on General Safety Provisions (GRSG) is the subsidiary body of the World Forum for Harmonization of Vehicle Regulations (WP.29) that prepares regulatory proposals on general safety. This group of experts conducts research and analysis to develop general safety requirements for vehicles, in particular buses and coaches. One of its informal working groups is dedicated to vulnerable road users.

- **Vulnerable Road Users (VRU-Proxi)**

The IWG on Awareness of Vulnerable Road Users Proximity (VRU-Proxi) is working on different contents related to the following regulations:

- **UN Regulation No. 46 (Devices for indirect vision)** – a proposal amendment (GRSG-115-39) to UN Regulation No. 46 was submitted with the aim to provide the driver, when moving his vehicle backwards, with a full field of vision on the rear proximity of the vehicle without any blind spots. However, the proposal was withdrawn and, instead, the informal working group started developing, on April 2019, a new draft UN Regulation which would address a broader scope. The new UN regulation on uniform provisions concerning the approval of devices for reversing motion and motor vehicles regarding the driver's awareness of vulnerable road users behind vehicles is still being developed.
- **UN Regulation No. 73 (Lateral protection devices)** – a proposal to improve the performance level of LPD that offer better protection to vulnerable road users is being investigated.
- **UN Regulation No. 93 (Front underrun protection) –** Proposals to amend regulation No. 93 are being prepared in order to update the provisions on frontal underrun protection to be approved as integrated part of the vehicle, and to allow more a rounded shape of cabs for better aerodynamic performance.

### 1.1.6 WP.30 - Working Party on Customs Questions affecting Transport

The Working Party on Customs Questions affecting Transport (WP.30) is the inter-governmental forum which prepares, reviews, modifies and administers a large number of United Nations conventions and agreements in the field of border crossing facilitation.

One of the conventions that falls under the scope of the WP.30 is the International Convention on the Harmonization of Frontier Controls of Goods. This convention's objective is to facilitate border crossing in the international transport of goods through the harmonization and reduction of the requirements for completing formalities as well as the number and duration of controls at borders. In the last session held in February 2020, the working party considered that due to the absence of provisions dealing with Information and Communication Technologies, it should be improved and thus, new ideas should be brought up in following sessions.

The working party is currently working in a project launched in 2003 that is aimed at providing an exchange platform for all actors involved in the TIR system, the "eTIR international system". The system's objective is to ensure a secure exchange of data between national Customs systems related to the international transit of goods, vehicles or containers.

TIR system was created in 1949 by IRU (International Road Transport Union). IRU has been contributing to EU policies and legislation for over more than 70 years, promoting and economically sound operating environment for road transport, ensuring fair competition and seeking a transport industry that plays a leading role in mobility.

## 1.2 EC level

In 2020, the New Sustainable and Smart Mobility Strategy was adopted by the European Commission. This strategy sets out the European vision for transport systems in the near future and the action plan. [4]
The plan is structured around three key objectives, making the European transport system:

- Sustainable.
- Smart.
- Resilient.

[4] https://ec.europa.eu/transport/sites/default/files/legislation/com20200789.pdf

The main objective is to achieve a 90% of reduction in transport-related greenhouse gas emissions by 2050. The strategy sets out milestones where the EU wants to be in 10 and 30 years from now.

By 2030:

- At least 30 million zero-emission vehicles will be in operation on EU roads.
- 100 European cities will be climate neutral.
- High-speed rail traffic will double.
- Scheduled collective travel of under 500 km should be carbon neutral within the EU.
- Automated mobility will deploy a large scale.
- Zero-emission vessels will become ready for market.

By 2035:

- Zero-emission large aircraft will become ready for the market.

By 2050:

- Nearly all cars, vans buses as well as new heavy-duty vehicles will be zero-emission.
- Rail freight traffic will double.
- High-speed rail traffic will triple.
- The multimodal Trans-European Transport Network (TEN-T) equipped for the sustainable and smart transport with high speed connectivity will be operational for comprehensive network.

Following the strategy of the document, the Commission boosts the creation of new regulations on batteries, sustainable and safe all along their entire life, and the revision of rules on weights and dimensions of heavy-duty vehicles. In parallel, VECTO Regulation for the $CO_2$ emission calculation should also evolve in order to include the innovations of the vehicles and the being as comprehensive as possible given the vehicles that are on the road.

### 1.2.1 EU Regulation on CO2 emissions and fuel consumption of heavy duty vehicles (HDV CO2)

The Heavy-Duty Vehicle CO2 Determination Group aims at developing a complete certification procedure for the assessment of the CO2 emissions from heavy-duty vehicles. The group, under the lead of DG GROW and with close collaboration of DG CLIMA, provides a platform for an exchange of information and contributions from a wide group of stakeholders involved in the process.

The discussions within this interest and working group turn mainly around Regulation (EU) 2017/2400 as regards the determination of the CO2 emissions and fuel consumption of heavy-duty vehicles. This regulation is currently implemented only for a certain group of vehicles of categories N2 and N3, however a draft amendment has been developed in order to extend the scope of vehicle groups and categories to which the regulation shall apply. Specifically, short term amendments will introduce buses and lorries, electric vehicles (hybrid and BEV), together with additional components related to electric powertrain (i.e. electric engines, batteries, etc).

In the 20th HDV CO2 Editing Board meeting there were discussed the Working Documents for the HDV CO2 certification and verification of buses and lorries, especially the new annexes documents including the verification of air drag data for those vehicles, and the introduction of hybrid and electric heavy-duty vehicles.

The CO2 emissions and fuel consumption are therefore monitored and reported to the European Commission, who establishes credits and emission limits to the manufacturers. Until today, though, fines for the non-compliance of these limits have not been established yet.

In addition to this, there have been also some initiatives from the European Commission for the further development of R(EU)2017/2400 and VECTO tool[5] to trailers, semi-trailers and rigid lorries with bodywork. Possibly, by means of establishing a newly dedicated regulation. The VECTO tool is a simulation method created by the commission that is being used for the determination of CO2 emissions and fuel consumption of heavy duty trucks. The tool uses different parameters to determine the power consumption of every relevant vehicle

[5] https://ec.europa.eu/clima/policies/transport/vehicles/vecto_en

component: the main parameters are rolling resistance, air drag, masses and inertias, gearbox friction, auxiliary power and engine performance. In this regard, the group is working on the development of HDV CO2 certification for (semi)trailers and bodies.

# 2 Sounding board activity

The Sounding Board is composed by a group of experts with different background which in the end has allowed this project to be a success. Since the beginning of the project, several activities have been made and they are summarised in the following table:

| Date | Location | Type of meeting | Topic |
|---|---|---|---|
| March 18 | Dortmund | Workshop | Logistics |
| May 18 | Berlin | Meeting | Presentation to the AEROFLEX Executive Board in conjunction with the GA |
| October 18 | Rotterdam | Meeting | Follow-up project in conjunction with the GA |
| February 19 | Paris | Workshop | Regulatory Framework I |
| May 19 | Brussels | Workshop | Intelligent Access I |
| May 19 | Brussels | Meeting | Presentation to the DGs |
| September 19 | Paris | Workshop | Intelligent Access II |
| October 19 | Amsterdam | Meeting | Sounding Board meeting at the GA04 |
| May 20* | Barcelona | Meeting | Follow-up project in conjunction with the GA |
| October 20 – Jan 2021 | Online | Meeting | Interviews with stakeholders |
| February 2021 | Online | Workshop | Intelligent Access III - Quizzes |
| March 2021 | Online | Workshop | Intelligent Access IV - Newspaper |
| June 2021 | Online | Workshop | Intelligent Access V |

*Initially, a side event was prepared which its main focus was TRA2020. Unfortunately, the coronavirus crisis led to the cancelation of TRA2020.

In deliverable D7.1, the meetings held before September 2019 are analysed. In case further information is needed, please refer to that deliverable.

## 2.1 Workshop on Intelligent Access Policies II

In May 2019 the first workshop on intelligent access policies took place in Brussels, at ACEA facilities. After the good acceptance of the first meeting, a second meeting took place the 30th of September 2019 in Paris. This time, presentations were shared about the different approaches followed in other countries like Australia, Estonia and Sweden. Note that some of these presentations were presented in the workshops held in Brussels and Paris. The main ideas of the Intelligent Access concept summarised in this 2nd Workshop were:

- The right vehicle in the right road
- GPS + Data on gross and vehicle weight
- System based on exemptions
- Concentrate volumes in corridors (high capacity network)
- Expand to other types of road transport (ADR and special transport)
- Geofencing in cities for societal purposes

## 2.2 Sounding Board meeting at the GA04

The meeting took place in NLR facilities (Amsterdam) the 10th of October 2019. The first session AEROFLEX WP3 / WP5: Status, goals, achievements, intentions main objective was held to update all SB on the latest news of the technical WPs of the project. The second session in Joined Demonstrator Program Cluster 2.0 and AEROFLEX was prepared together with CLUSTER 2.0 to discuss about new modular units designed for being used in different types of cargo. This session discussions were leaded by Ton Bertens (Van Eck) and Marcel Huschebeck (PTV Group). The main objective was to optimize the utilization of the container and the loading/unloading of the cargos. In order to do so, different designs and ideas were presented. Finally, TNO also updated the status of duo trailers around Europe.

## 2.3 Interviews with stakeholders

During the year 2020 the focus was to understand better the concept of Intelligent Access Policies as the base for the regulatory framework at vehicle level was already settled in the first period of the project with deliverable D7.1. Because of the coronavirus situation, all the workshops and meetings had to be performed online during the second half of the project.

The interviews held between October 2020 and January 2021 were focused on getting feedback to which are the needs of the different stakeholder clusters, identified in previous workshops, that are related and/or affected somehow by the implementation of IAP. The interviews allowed the development of a Quiz which its goal was to identify the barriers and success factors for the implementation of IAP. Around 30 stakeholders were part of the consultation process.

## 2.4 Workshop on Intelligent Access Policies III (Quizzes)

In February 2021, a total of four one-hour sessions were held online. In these interactive sessions, the stakeholders were invited to a quiz where they could give their opinion and share their view on different relevant topics related to Intelligent Access Policies. The main objective of the quizzes was to validate and discuss the findings of the interviews.

A total of 19 participants joined the different sessions and gave their answers to the quiz questions. The quiz was divided in three parts:

- Part I – Warm Up (Introduction and what AEROFLEX has achieved so far)
- Part II – Introduction to Intelligent Access Policies (IAP)
- Part III – Towards IAP taskforce

Part I aimed at giving an overview of the AEROFLEX project in order to understand which knowledge the participants had of the project and which was their position on the use of the different EMS configurations. The second part of the quiz focused on understanding what is the current situation of Intelligent Access Policies in Europe. Questions asked in this second part strived at getting an opinion of the barriers, challenges, success factors and opportunities that the different stakeholders' clusters are facing. The last part of the quiz (Part III), was intended to get the different views on which are the next steps towards IAP deployment.

## 2.5 Workshop on Intelligent Access Policies IV (Newspaper)

Once the results of the quizzes were summarised and analysed by the team, a follow-up workshop was organised in two different sessions with the aim of developing a common view, among the different stakeholders, on Intelligent Access Policies. The two sessions were held in March 2021 and had a total of 12 participants (6 participants per session). The workshop was organised in a way that the participants of each session divided in two different working groups that aimed at setting up the base for an IAP newspaper that would be developed by the project. The concept of the newspaper was to imagine as if it were 2030 and give a look back on how Intelligent Access Policies became successful.

Some of the questions that were asked to the participants to give their thoughts to were: What has been done for this (stakeholder) group?, What did this (stakeholder) group gain?, What are the core achievements and steps that have been taken?...After analysing the different responses, during the following months, the newspaper was written and developed by the AEROFLEX team.

## 2.6 Workshop on Intelligent Access Policies V

Once the newspaper was written, a last workshop was organised with the aim of validating the information captured on it. This workshop was held in a two-hour session during June 2021 and had a total of 12 participants. During this workshop, the participants were shown some of the main phrases extracted from the newspaper and they were asked to give their opinion on it. The results of the workshop were used to adjust some of the newspaper's statements according to the stakeholders' view.

The final version of the newspaper, which has been a result of the abovementioned workshops, can be seen in Annex 1.

# PART B: Future recommendations at vehicle level

# 3 Regulatory framework update and recommendations

This chapter presents the study and analysis (from the point of view of regulatory framework) of what has been finally implemented in the AEROFLEX vehicles and what has been tested. An update of the regulatory framework matrix is given, and, for each regulation, the recommendations to update them so that they allow the introduction of the solutions implemented are given.

## 3.1 WP2 - Advanced Energy Management Powertrain (AEMPT)

The objective of this chapter is to review the solutions implemented in Work Package No.2 (WP2) and to update the Regulatory Matrix accordingly. The aim is to have a common knowledge of the regulatory gaps or conflicts that the solutions implemented may face during the type-approval process.

With the objective of reducing fuel consumption of EMS vehicles by advanced powertrain technology, a key idea is to combine the conventional or hybrid powertrain of the pulling vehicle with electric drives in other vehicle units, thereby creating a distributed hybrid drive. This concept might allow to install a downsized combustion engine which is supported by electric drives in the trailer units, if coupled to the truck. In turn AEROFLEX vehicles would allow a flexible combination of vehicle units which bring their own driveline into the combination.

As known, WP2's - Advanced Energy Management Powertrain (AEMPT) - objective has been to investigate the feasibility and the potential of hybrid heavy duty trucks including the technical and commercial feasibility, and the potential of distributed electric drivetrains as a migration step towards fully electric drivetrains.

### Final solutions implemented

The main approach has always been to combine a conventional or hybrid powertrain of the pulling vehicle with electric drives in other vehicle units, thereby creating a distributed hybrid drive. The reason behind is to reduce fuel consumption of EMS vehicles by advanced powertrain technology.

It has been proved that the implementation of an AEMPT would allow to install a downsized combustion engine which is supported by electric drives in the trailer units, if coupled to the truck. This allows a flexible combination of vehicle units which bring their own driveline into the combination.

When looking on the large number of EMS-configurations identified in previous deliverables, it became obvious that it would not be possible, within the scope of this project, to assess each of them in terms of fuel saving potential or vehicle dynamics. Therefore, the distributed powertrain technology developed in WP2 has been demonstrated at two different vehicle categories, being EMS1 and EMS2.

As a demonstrator of AEMPT EMS1, it has been considered, as testing vehicle, a steered E-dolly and a conventional curtain-sided semi-trailer. AEMPT EMS1 configurations uses the same truck as used in the MAN EMS1 reference (MAN 6x2 Truck).

Besides EMS1 configurations, it has been considered essential to treat vehicle concepts beyond current state-of-the-art, so EMS2 configurations have also been included with distributed powertrain technology. These configurations are especially of interest to see whether a current 4x2 tractor with 13l engine is able to deal with this longer and heavier configuration when air drag is reduced and the powertrain is assisted by an E-dolly (or E-trailer, depending on the case). For this reason, the AEMPT EMS2 demonstrators use a MAN 4x2 tractor.

In addition, another decision has been made because this is an extreme heavy configuration and a high potential configuration in terms of fuel energy savings. Therefore, two aerodynamic settings for AEMPT EMS2 have been tested. One of them, only showing the pure AEMPT contribution (only e-dolly) and the other one with combined AEMPT and best aerodynamic settings possible (including aerodynamic appendixes and improvements). The latter also quantifies the statement whether 4x2 tractors with 13l engines can deal with this EMS2 configuration while supported by lower air drag and assisted by the distributed powertrain.

The specific vehicle configurations that have been tested are:

AEMPT EMS1:

- 6x2 Rigid truck–e-Dolly–Semitrailer (EMS1).

AEMPT EMS2:

- 4x2 Tractor-Semitrailer-e-Dolly-Semitrailer (EMS2): without aerodynamic features.
- 4x2 Tractor-Semitrailer-e-Dolly-Semitrailer (EMS2): with aerodynamic features.

Figure 8 below shows the conceptual image of the e-Dolly that has been developed as a demonstrator of this work package and that has been included into the tested vehicle configurations.

**Figure 8. E-dolly**

## Matrix

The regulatory matrix containing all the regulations that may be involved in the implementation of an AEMPT has been reviewed according to the latest updates, especially focused on the implementation of the e-dolly as part of the vehicle combination. Relevance has been divided in High, Medium and Low to determine how much effect may have the regulation to an AEMPT.

| | | *Relevance* | *Vehicle* | *Use* | *Infrastructure* |
|---|---|---|---|---|---|
| UNECE REGULATIONS | UN R10: Electromagnetic compatibility EMC | High | X | | |
| | UN R13: Braking provisions to M, N and O vehicles | High | X | | |
| | UN R48: Installation of lighting and light-signalling devices | Low | X | | |
| | UN R55: Coupling components | High | X | | |
| | UN R79: Steering equipment | High | X | | |
| | UN R100: Electric power train | High | X | | |
| | UN R105: Specific features for carriage of dangerous goods | Low | X | X | X |
| EU directives & | Regulation (EC) 1230/2012: Masses and dimensions | High | X | X | X |
| | Directive (EU) 2015/719: Masses and dimensions in international traffic | High | X | X | X |
| | Regulation (EU) 2017/2400: CO2 emissions and fuel consumption of heavy-duty vehicles | High | X | | |

| | | | | | |
|---|---|---|---|---|---|
| | Regulation (EU) 2019/1242: CO2 emission performance for new heavy-duty vehicles. | High | X | | |
| | Regulation EU 2018/858: Framework regulation | High | X | | |
| | Directive (EC) 2006/126: Driving licenses | High | | X | |
| | Directive (EC) 2003/59*2006/103: Training of drivers | High | | X | |
| | Directive (EU) 2014/45: on periodic roadworthiness tests | Medium | X | | |

**Table 1. WP2 regulatory matrix (updated according to implemented solutions)**

### 3.1.1 UN Regulation No. 10: Electromagnetic compatibility EMC (High – Vehicle)

Any electric/electronic component or separate technical unit introduced in a EV (for example, the e-dolly) shall be approved under this regulation. In addition, not only the separate components but the whole vehicle shall be then tested and approved under the regulation in order to ensure the electromagnetic compatibility of the whole assembly working together.

In the case of an e-dolly, it is especially important to take into consideration the approval of the REESS (rechargeable energy storage system) and the coupling system for charging the REESS. These components are already within the scope of the regulation, and therefore no recommendations for updates or modifications are needed due to the implementation of the AEMPT.

### 3.1.2 UN Regulation No. 13: Braking provisions to M, N and O vehicles (High – Vehicle)

First of all, changes of regulation shall include provisions for towed vehicles with towing capacity (for example, dollies, link-trailers, etc.) that may not necessarily be provided with electric motors. Shall be introduced in the regulation in aspects related with the special braking circuits required by a dolly (these discussions are being held in the MVC (Modular Vehicle Combination) working group dependant from GRVA). With regards to this, Supplement 18 of 11 series of amendments of the regulation including prescriptions on certain EMS vehicle combinations is expected to enter into force at the end of September 2021.

Other changes that could be considered to be introduced in the regulation include the allowance of these towed vehicles with towing capacity, but which could additionally drive on its own under specific circumstances. Therefore, modification shall be made in the regulation, in order to introduce the scenario of having both: brake torques of friction brake, the so-called endurance brakes, and e-motors on trailers.

Annex 16 of the Regulation describes de requirements of the compatibility between towing vehicles and trailers with respect to ISO11992 data communications. The ISO shall be modified (or a new one created) in order to include the requirement for an Automotive Ethernet signal on the ISO7638/ISO11992 connector.

***Recommendations***

The introduction of EMS and electric trailers in the regulation shall also include the allowance of variable or adjustable distribution of brake power of the combination under certain dynamic conditions, controlled in all cases by a smart ECU.

Specific requirements for the response time of the different vehicles included in an EMS shall also be introduced. The limit values to be considered for each vehicle should be the same as for any other trailer (0,4 seconds), ensuring in that way that the towed vehicle always brakes slightly after the towing vehicle, but also before the next towed one in the configuration. This is already covered in the coming Supplement 18 of 11 series of amendments of the regulation, however not for all the possible combinations. Further amendments of the regulation will need to introduce additional types of towing-trailers and combinations; therefore requirements will need to be elaborated to meet the maximum of 0,4 seconds for the time response (0,4 seconds for each trailer individually).

Since the circumstances where the e-dolly could be driven remotely or autonomously are very specific (only for manoeuvring on loading and unloading docks) it is considered that no additional requirements are necessary for these scenarios.

### 3.1.3 UN Regulation No. 48: Installation of lighting and light-signalling devices (Low – Vehicle)

The e-dolly and e-trailer shall comply with the requirements of this regulation, specific for category O vehicles. However, modifications could be made in this regulation in order to introduce the Modular Vehicle Combinations. Currently the requirements for these types of combinations are included in the specific traffic regulations for each country where MVC are allowed.

In any case, no additional recommendations for updates or modifications are needed due to the implementation of the AEMPT.

### 3.1.4 UN Regulation No. 55: Coupling components (High – Vehicle)

Dolly definition is included in Supplement 7 to the 01 series of amendments and defined as "a towing trailer designed for the sole purpose to tow a semi-trailer", the supplement includes as well calculation formulas applicable to Multi-vehicle combinations (new Annex 8). However, there are other configurations/scenarios that shall be introduced in this regulation, such as centre axle trailers capable of carrying loads and equipped with coupling to tow a trailer, link-trailers (semi-trailer equipped with a fifth-wheel) and semi-trailers equipped with couplings to tow a trailer. These cases are described in Annex 8 (combinations 1 to 6) but not properly defined within the main text of the regulation.

***Recommendations***

In the next supplement of the regulation it is recommended to include definitions, in Section 2 of the abovementioned regulation, for the following concepts:

- Towing centre axle trailer.
- Towing semi-trailer.
- Link-trailer.

### 3.1.5 UN Regulation No. 79: Steering equipment (High – Vehicle)

There is no reference in the regulation for requirements of the steering equipment regarding the concept of active side skirt extensions. This regulation might not be the proper one to include requirements of the device itself, however it may be necessary to have a regulation that includes issues as, for example, the possible interference between the active side skirt extensions and the wheels of the semi-trailer in case of vehicles with steering equipment.

In terms of the steering system, the development and inclusion of the new aerodynamic devices do not affect the system itself. Provisions and requirements of this regulation are focused on the robustness of the design of the steering system (in the case that any of the trailers include it), and how to test it (mainly checking the effort and the manoeuvrability).

The regulation includes specific tests required only for trailers, with the aim to evaluate that the trailer travels without excessive deviation from the towing vehicle. The regulation defines a test in order to verify the area swept by the trailer in a curve when the towing vehicle is travelling at different speeds. For MVC the test should be repeated including the whole combination of vehicles (tractor vehicle + trailers). As it is clear that adding more than two vehicles in a combination implies a significant increase in the length that could penalize the manoeuvrability of the combination, hence, modifications should be done in order not to penalize the use of these technologies (in a similar way as it has been done in the regulation for masses and dimensions).

***Recommendations***

The first proposal would be to update or modify the definition of trailer in order to include which vehicles within the combination shall be considered as towing and as towed. It is important to establish how to apply the manoeuvrability requirements.

For the manoeuvrability of the trailer, it is necessary to understand what is being required for trailers with regards to its deviation when moving at different speeds. As example, the regulation defines the following test:

*""6.3.2. With the towing vehicle and trailer having adopted a steady state turn corresponding to a turning circle radius of 25 m (see paragraph 2.4.6.) at a constant speed of 5 km/h, the circle described by the rearmost outer edge of the trailer shall be measured. This manoeuvre shall be repeated under the same conditions but at a speed of 25 km/h ±1 km/h. During these manoeuvres, the rearmost outer edge of the trailer travelling at a speed of 25 km/h ±1 km/h shall not move outside the circle described at a constant speed of 5 km/h by more than 0.7 m."*

So, the maximum difference between the swept area by the rearmost outer edge of the trailer at 5 km/h and 25 km/h is set at 0.7 m.

If the definition of a trailer with respect to the towing vehicle is updated to be considered as all towed vehicles included in the combination (it means, all the trailers: dolly + semi-trailer in case of EMS-1, or semi-trailer + dolly + semi-trailer in case of EMS-2), then the maximum difference required between the swept area at both speeds shall be modified. Otherwise, specific prescriptions could also be introduced to allow the fulfilment of the manoeuvrability requirements only between each towing and towed vehicle, but not for the whole combination.

### 3.1.6 UN Regulation No. 100: Electric power train (High – Vehicle)

Trailers are currently not included in the scope (02 series of amendments of regulation only applies to M and N category vehicles); therefore, the regulation shall be updated in order to include them. It shall be defined where the batteries may be located on the **trailers**.

There is a proposal for 03 series of amendments already adopted, which is about to be published in the 3rd quarter of 2021. However, this new series of amendments does not include trailers within the scope of the regulation.

In the case that the batteries or capacitors are located on the trailer, together with the amount of flow of electricity, the regulation shall include requirements with regard to the connection/disconnection of the power cables between the towing and towed vehicle, or even consider the possibility of having automatic connection/disconnection of such power cables in order to prevent the driver to handle HV cables and reducing the risk of possible injuries.

***Recommendations***

The scope of the regulation should be extended to cover also trailers, which may be equipped with e-axles and/or REESS to provide assistance to the drivetrain of the tractor unit or vehicle combinations. In these situations, though, each vehicle equipped with components related to the electric drivetrain of the combination shall comply with this regulation of electrical safety requirements.

### 3.1.7 UN Regulation No. 105: Specific features for carriage of dangerous goods (Low – Vehicle, Use and Infrastructure)

The provisions of this regulation apply to the construction of vehicles of category N and their trailers, of category O, intended for the transport of dangerous goods and which are subject to section 9.1.2. of Annex B of the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). However, the ADR still does not cover the option of electric or electrified vehicles, and therefore an AEMPT cannot be subject to this regulation yet. Additionally, MVC are not covered either within the ADR.

***Recommendations***

No recommendations are to be described, rather than that the regulation shall be amended in order to include electric and electrified vehicles. Regarding to this, an ADR dedicated new section was created at the beginning of 2021, under the scope of GRPE's Informal Working Group on Electrical Vehicles (IWG-EV), in order to present the inputs for discussions and approvals or present proposals of ADR's modifications at each meeting of the Group. Until now, only discussion topics have been presented, without any formal proposal.

### 3.1.8 Regulation (EC) 1230/2012: Masses and dimensions (High - Vehicle, Use and Infrastructure)

Regulation (EC) 1230/2012 has been amended by Regulation (EU) 2019/1892, which includes requirements for motor vehicles fitted with elongated cabs and it specifies what conditions shall a vehicle comply to be considered an elongated cab. However, there are still no definitions nor requirements for dollies. Modular Vehicle Combinations are also not covered by this regulation, and therefore the requirements of the maximum mass and lengths for those combinations, if allowed in individual countries, are left to the application of Directive (EU) 2015/719, where those vehicle combinations are not defined, as explained in following paragraph.

New amendments have introduced new definitions, requirements and tests for aerodynamic devices. As a summary of the main requirements for the aerodynamic devices, the following remarks are to be considered:

- These devices should not be taken into account on the dimension requirements ("due to their design, those devices and equipment may project beyond the outermost part at the front, back or laterally of the vehicles on which they are fitted. Therefore, vehicles fitted with such devices and equipment should be exempted from the requirements relating to the standard dimensions.").
- The list of Appendix 1 of Annex 1 defines the devices that are not required to be taken into account for the determination of the outermost dimensions and it has been updated.

Above all of this, devices laid down within the framework shall consider the need to ensure road safety and safety of intermodal transport operations. In particular, the secure attachment of the devices in such a way as to reduce the risk becoming detached over time, including during intermodal transport operations. Additionally, the safety of other road users, especially vulnerable road users, must be ensured by guaranteeing the visibility of contour markings when the aerodynamic devices are fitted and, in the event of a collision with the rear of a vehicle, by not compromising the rear underrun protection.

Regarding the operational conditions of the devices, the regulation establishes a set of rules:

- In circumstances where the safety of road users or the driver is at risk, they shall be folded, retracted or removed.
- Their use on urban and interurban road infrastructures shall take into account the special characteristics of areas where the speed limit is less than or equal to 50 km/h and where vulnerable road users are more likely to be present.
- Their use shall be compatible with intermodal transport operations and, in particular, when retracted/folded, they shall not exceed the maximum authorized length by more than 20 cm.

***Recommendations***

In terms of masses and dimensions requirements, the dolly is not included in the definitions of the regulation yet. It shall be modified to include this type of vehicle, including also any other trailer with towing capacity. In addition, this type of vehicles shall comply with the mass of combination formula and manoeuvrability requirements stated in Part D of Annex 1 of the regulation.

To complement this, towing capacity requirements should be introduced also in Part D of Annex 1 (vehicles of category O), which should be most probably very similar to the towing capacity requirements already established for category N2 and N3 vehicles.

### 3.1.9 Directive (EU) 2015/719: Masses and dimensions in international traffic (High - Vehicle, Use and Infrastructure)

This directive amends 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. It shall be ensured that, when an e-dolly or e-trailer is used in a combination of vehicles, Article 10d of this directive is being complied and any data coming from any type of trailer or semi-trailer attached to the motor vehicle can be received and processed by the on-board system of the motor vehicle.

However, this amending directive nor any of the following amending acts (Decision (EU) 2019/984 and Regulation (EU) 2019/1242) include any modifications to increase the maximum length and total authorised weight of the MVC.

***Recommendations***

Points 1.1 and 2 of Annex I of Directive 96/53/EC and its amendments should be updated in order to cover the possible combinations of MVC and to establish limits on the maximum authorized length of the vehicle combination and their maximum authorized vehicle weight.

In addition, even it is not a recommendation but a reminder of an crucial aspect: it shall be empathized that its important to still ensure that the weight borne by the driving axles of a vehicle combination must not be less than 25 % of the total laden weight of vehicle combination, especially when considering MVC.

### 3.1.10 Regulation (EU) 2017/2400: CO2 emissions and fuel consumption of heavy-duty vehicles (High – Vehicle)

The regulation sets out the rules for issuing licenses to operate a simulation tool (popularly called VECTO) with a view to determining $CO_2$ emissions and fuel consumption of new vehicles to be sold, registered or put into service.

The European Commission developed the computer simulation tool called VECTO, which is able to determine the CO2 emissions of heavy-duty vehicles using measured and certified input data according to the properties of the vehicle's components and detailed specifications. As from January 2019, every new truck defined in the VECTO vehicle groups has an official value of CO2 given by this tool.

At this moment, it only applies to certain N2 and N3 vehicle groups, but it is a first step to future regulations that will cover further categories. There is a draft second amendment being developed that will cover also large buses and other medium and large lorries.. In addition, there are several initiatives and tenders working on the inclusion of electric powertrain and electric components, such as e-motors, e-axles, etc. and bodies and trailers, within the scope of VECTO.

The main issue of the current version of the regulation is the non-inclusion of bodies and trailers on CO2 calculation. European Commission is working on it through public tender "Support Preparation of Legislation on Trailers Certification"[6] and two dedicated Task Forces (Trailer certification and CFD) and will publish their draft results by the beginning of 3rd quarter of 2021. The main objective of these tenders is the inclusion of category O vehicles, in order to better reflect the reality determining the CO2 emissions and the contribution of the aerodynamic devices mounted on these vehicles to improve their air drag value, and therefore, improve the fuel consumption and thus, reduce the CO2 emissions of the vehicle combination.

***Recommendations***

In line with the tenders issued by the European Commission, the steps that should consider the future amendment of this regulation are summarised in the following paragraphs.

From the aerodynamic perspective, the recommendation is lined up to what already is in process: inclusion of vehicles of category O into VECTO (mainly O3-O4), which would allow to calculate the contribution of trailers to the CO2 determination (by means of % of reduction).

Accordingly, aerodynamic tests for the trailers should be defined with a baseline truck or tractor (depending on the vehicle that is going to be evaluated). One option could be to compare the results obtained for a trailer without aerodynamic devices with another that is fitted with all of them, in order to obtain the air drag reduction provided by their usage. Another possible option is to provide standard values to each aerodynamic device (by means of look-up tables, CFD simulation or even CST tests) in order to establish a % of air drag coefficient improvement).

From the electrical vehicle point of view, the e-dolly, due to its characteristics and given the fact that normally, when in use, it is towing another trailer, could be left out in the air drag calculation because the effect on it is minor and probably negligible. However, it will take more importance when analysing the power supply given by the electric motor of the dolly, according to the performed tests.

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[6] CLIMA.C.4/SER/2019/0003 - Support Preparation of Legislation on Trailers Certification: https://etendering.ted.europa.eu/cft/cft-display.html?cftId=4833

### 3.1.11 Regulation (EU) 2019/1242: CO2 emission performance for new heavy-duty vehicles (High – Vehicle)

This regulation applies to N2 and N3 categories of vehicles, however it is a good example of how future amendments and new vehicle regulations will focus on CO2 emissions reduction from the road transport sector. CO2 emissions reduction targets for N2/N3 vehicles are -15% in 2025 and -30% in 2030, compared to 2019/2020 emission values.

There have been several initiatives from the European Union for developing measures to reduce the CO2 emissions, as for example the published "Bodies and trailers – Development of CO2 emissions determination procedure"[7], from DG-CLIMA. Further procedures for a CO2 certification of trailers are under development and shall be finalised until end of 2021. So, there are no additional recommendations within this regulation, since it is known that European Commission is working already on a regulation for CO2 emissions specific for trailers and bodies.

### 3.1.12 Regulation (EU) 2018/858: Framework regulation (High – Vehicle)

In terms of Vehicle Type, and notwithstanding the definition of an electric trailer (e-dolly or e-trailer), it must be noted that a non-electric dolly is not a standard trailer, therefore is not currently considered in Regulation (EU) 2018/858 (repealing former Directive (EU) 2007/46), for European Whole Vehicle Type Approval.

***Recommendations***

Modifications shall be made to Regulation (EU)2018/858 in order to consider dollies within its scope. This same principle shall be applied for all those trailers or semi-trailers equipped to tow another trailer/semi-trailer. This is a major characteristic in most of the analysed regulations: MVC are not covered yet.

Also, additionally new definitions shall be included for the electric dolly and electric trailers in general.

### 3.1.13 Directive (EC) 2006/126: Driving licenses (High – Use)

Currently, even in the latest amendment of the directive by Directive (EC) 2020/612, driving licences of categories C1E and CE consider only combinations of vehicles formed by tractor vehicle + 1 trailer or semi-trailer.

***Recommendations***

Modifications shall be made in order to include in the scope the option of driving combinations of vehicles with more than one trailer or semi-trailer (it means, including dollies, link-trailers and others) with the aim to align the driving license procedures and tests to the vehicle combinations that are available on the roads. Specific requirements for training and testing the drivers shall be considered and implemented at European level (some countries are already implementing it within their territories).

### 3.1.14 Directive (EC) 2003/59*2006/103: Training of drivers (High – Use)

This directive established the requirements for the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers, and its last amendment is Regulation (EU) 2019/1243. Up to today, the directive does not include any requirements nor even reference to the handling of electric vehicles or their HV connections.

***Recommendations***

If Directive 2006/126/EC is to be modified, this directive shall therefore be affected by those modifications too and needs to be amended, as well, in the same way.

In addition, even considering that the manipulation of the electric system of the vehicles is not required by the drivers as these are considered maintenance and repair works, training of drivers shall include the handle of HV cables on electrified tractors and trailers, as well as on connections of HV cables between the tractor and the trailer (or even between trailers in the case of MVC).

[7] https://ec.europa.eu/clima/sites/default/files/transport/vehicles/heavy/docs/report_bodies_trailers_en.pdf

### 3.1.15 Directive (EU) 2014/45: on periodic roadworthiness tests (Medium – Vehicle)

The analysis of this regulation is linked to the one of Regulation (EU) 2018/858, as already explained in paragraph 2.1.13. The directive does not include any definition or requirement for towed vehicles with towing capacity as used for the MVC, and therefore these vehicles do not have any specific requirements within the scope of the directive.

***Recommendations***

Modifications shall be introduced, together with the definitions in Regulation (EU) 2018/858, to include towed vehicles with towing capacity, and also e-dollies and e-trailers.

## 3.2 WP3 - Aerodynamic Features for the Complete Vehicle (AFCV)

Work Package 3 (WP3) has developed several aerodynamic features for the complete vehicle, that are both active and passive. The main objective of the features is to reduce the energy consumption and CO2 emissions from improved aerodynamics. The active aerodynamic features allow the vehicle to ensure optimum performance in different situations without restrictions while loading or unloading the cargo.

### Final solutions implemented

The final solutions proposed by WP3, according to its CFD results and cost benefit analysis, may be split in three groups. There is a total of 14 solutions that will be applied to the truck, dolly or trailer.
As the requirements on the legislative acts (UN or EU) normally are defined according to the category of the vehicle, for the purpose of this deliverable, the gaps and proposals for the possible amendments will also be separated according to the vehicle. Therefore, the list of the aerodynamic solutions for each vehicle are listed below.

Truck
- Active air deflector.
- Adjustable ride height.
- Truck side skirt extension.
- Swap body with movable roof.
- Underbody covers.
- Gap reducer.

Dolly
- Aerodynamic shaped dolly skirts.
- Adjustable ride height.

Trailer
- Adjustable ride height.
- Movable roof.
- Active side skirt extensions.
- Diffusor.
- Adaptable boat tail.
- Boat tail side panel extension.

**Figure 9. Set of aerodynamic devices installed to the vehicles**

As a first step, a wide analysis to the New General Safety Regulation (EU) 2019/2144 (hereafter GSR) is going to be provided, in terms of improvements related to the aerodynamic devices and safety. The new GSR pays a lot of attention to the protection of Vulnerable Road Users (VRU), thus introduces a several number of systems that will

help reduce the fatalities involving pedestrians or cyclists. The major factor that involves trucks in these accidents is the lack of direct visibility around the truck cab.
As a preamble of the requirements of the regulations, item 22 defines that direct vision should be improved, and blind spots reduced:

> *"(22) ….. The number of casualties could be reduced significantly by improving direct vision.* ***Requirements should therefore be introduced to improve direct vision to enhance the direct visibility of pedestrians, cyclists and other vulnerable road users from the driver's seat by reducing to the greatest possible extent the blind spots in front and to the side of the driver****. The specificities of different categories of vehicles should be taken into account."*

Hence, all the implementations, mainly in the truck vehicle, shall take into account that the side-visibility of the driver would never be affected by its usage.

Additionally, for all these systems that are used through electronic software, and are subject to be updated during the lifecycle of the vehicle, the regulation also defines a set of requirements regarding the software updates versions used by the manufacturer:

> *"(27) Software modifications can significantly change vehicle functionalities. Harmonised rules and technical requirements for software modifications should be established in line with the type-approval procedures. Therefore, UN Regulations or other regulatory acts regarding software update processes should be applied on a mandatory basis as soon as possible after their entry into force. …"*

This last requirement is being adopted with the UN Regulation No. 156 that has been approved at the beginning of 2021 and will be mandatory for all the vehicles as from 2022.

What becomes important when talking about aerodynamic devices, are regulations of masses and dimensions, which legislate overall measures of the vehicles and the devices. Currently, there are two main types of regulations about trucks' masses and dimensions.

- On one side, there are general regulations for international transport at the EU level.
- On the other side, national and local regulations.

Directive 2015/719 is the one that sets the maximum dimensions for international traffic, but also ensures that the Member States can't restrict the circulation to the vehicles that comply with the limits defined within their territories. The directive, grants derogations on the maximal lengths to make heavy goods vehicles greener by improving the aerodynamic performance. These rules are complemented by the requirements for type-approval of commercial vehicles, especially Regulation (EU) 1230/2012, last amended by Regulation (EU) 2019/1892.

It is important to highlight this last regulation, as it is the one that currently sets the maximum dimensions of these devices and how can they be certified and tested. For this working package, due to the influence of the aerodynamics devices to the measures of the vehicle, it is considered the most important regulation to be taken into account. Therefore, the new amendment introduced on 2019, with Commission Regulation (EU) 2019/1892, with regards to requirements for motor vehicles fitted with elongated cabs and aerodynamic devices and equipment for motor vehicles and their trailers, grows in importance given that it introduces new requirements and tests for aerodynamic devices.

It is important to remark that according to this regulation, these devices should not be taken into account on the sum of the total dimensions of the vehicles, as it would be a constraint for the manufacturers instead of a benefit:

> *(2) Aerodynamic devices and equipment, such as for instance retractable or foldable flaps attached to the rear of trucks and their trailers, as well as aerodynamic devices and equipment for cabs are currently available technology with a potential for improving the aerodynamic performance of vehicles. However, due to their design, those devices and equipment may project beyond the outermost part at the front, back or laterally of the vehicles on which they are fitted. Therefore, vehicles fitted with such devices and equipment* ***should be exempted from the requirements relating to the standard dimensions****.*

This means that the use of these devices does not prejudice the manufacturer or the user in defiance of load capacity. However, the regulation also introduces a list on Appendix I with the devices that are exempted.

Apart from the dimensional exemptions, the regulation divides the aerodynamic devices between those that do not exceed more than 500 mm in length in the in-use position, and those that exceed this length. Requirements set out on the regulation are different on each category, being stricter for devices of more than 500 mm, to ensure users safety.

Requirements for devices of < 500 mm

1. These devices shall not in any case increase the usable length of the loading area.
2. Shall be constructed in a way that makes it possible to lock them in both retracted or folded and in-use position.
3. It shall be possible to vary the position of the equipment by applying a force less than 40 daN. There is the possibility to make it automatically.

Requirements for devices of > 500 mm

1. These devices shall not in any case increase the usable length of the loading area.
2. Shall be constructed in a way that makes it possible to lock them in both retracted or folded and in-use position.
3. It shall be possible to vary the position of the equipment by applying a force less than 40 daN. There is the possibility to make it automatically.
4. Each main vertical element or combination of elements and main horizontal element or combination of elements forming the devices and equipment shall, when installed on the vehicle and in the in-use position, withstand vertical and horizontal traction and push forces, applied sequentially in up, down, left and right direction, of 200 daN ± 10 % applied statically to the geometric centre of the relevant perpendicular projected surface, at a maximum pressure of 2,0 MPa. The devices and equipment may deform, but the system for adjustment and locking shall not release as a result of the applied forces.

Above all of this, devices laid down within the framework shall consider the need to ensure road safety and safety during intermodal transport operations. In particular, the secure attachment of the devices in such a way as to reduce the risk of becoming detached over time, including during intermodal transport operations. Additionally, the safety of the other road users, especially vulnerable road users, by ensuring the visibility of contour markings when the aerodynamic devices are fitted and, in the event of a collision with the rear of a vehicle, by not compromising the rear underrun protection.

Regarding the operational conditions of the devices, the regulation establishes a set of rules:

- In circumstances where the safety of road users or the driver is at risk, they shall be folded, retracted or removed.
- Their use on urban and interurban road infrastructures shall take into account the special characteristics of areas where the speed limit is less than or equal to 50 km/h and where vulnerable road users are more likely to be present.
- Their use shall be compatible with intermodal transport operations and, in particular, when retracted/folded, they shall not exceed the maximum authorized length by more than 20 cm.

## Matrix

The global result of the regulatory analysis for aerodynamic devices is shown in Table 2. Mainly, the introduction of the aerodynamic devices to the vehicles of the project, affects the vehicle part of the current legislation. As explained before, during the last few years, the European Commission and the different stakeholders of the vehicle

have put big efforts to implement changes in the Masses and Dimensions regulation, in order to allow the deployment of these devices in Europe.

| | | *Relevance* | *Vehicle* | *Use* | *Infra.* |
|---|---|---|---|---|---|
| UNECE REGULATIONS | UN R29: Protection of the occupants of the car | High | X | | |
| | UN R13: Braking System | Medium | X | | |
| | UN R73: Lateral Protection | Low | X | | |
| | UN R79: Steering Sytem | Medium | X | X | |
| | UN R58: Rear Underrun Protection | Low | X | | |
| | UN R105: ADR | Low | X | | |
| | UN R121: Controls, signals and tell-tale | Medium | X | | |
| EU directives & regulations | Regulation (EC) 1230/2012: Masses and dimensions | High | X | X | X |
| | Directive (EU) 2015/719: Masses and dimensions in international traffic | High | X | X | X |
| | 2017/2400: Determination of the CO2 emissions and fuel consumption | High | X | | |
| | 2018/858: Approval of motor vehicles | Low | X | | |

**Table 2. WP3 regulatory matrix (updated according to implemented solutions)**

### 3.2.1 European Regulation (EU) 2017/2400

The European Commission developed a computer simulation tool called VECTO, which is able to determine de CO2 emissions of the heavy-duty vehicles using measured and certified input data according to the properties of the vehicle's components and detailed specifications. As from January 2019, every new truck defined in the VECTO vehicle groups has an official value of CO2 given by this tool.

At the beginning this regulation only applies to N2 and N3 vehicles (with some exemptions).

The regulation does not define exactly which devices may be fitted in the vehicle for the calculation of the CO2. However, it defines that vehicles measured through the tests of the regulation, shall be according the masses and dimensions explicitly mentioned in Regulation (EC) No. 1230/2012.

The first main issue of the Regulation is the non-inclusion of bodies and trailers on CO2 calculation. However, the European Commission is currently working on it through public tenders that will publish their results by the end of June 2021. The main objective of the tender is the inclusion of category O vehicles, in order to better reflect the reality determining the CO2 emissions.

***Recommendations***

In line with the tenders issued by the European Commission, one of the first steps that should be taken into account the future amendment of this regulation is:

- Inclusion of other categories of vehicles: mainly O categories, which would allow to calculate the contribution of trailers to the CO2 determination. Probably, one of the areas of the trailer that affects more to overall CO2 per km of a combination, is the aerodynamics of the vehicle.
  Accordingly, aerodynamic tests for the trailers should be defined with a baseline truck or tractor (depending on the vehicle that is going to be evaluated). One option could be to compare the results obtained for a trailer without aerodynamic devices with another that is fitted with all of them, in order to obtain the air drag reduction provided by their usage.

The dolly, due to its characteristics and given that normally is towing another trailer when is un use, could be not included in the air drag calculation because the effect on that area is probably negligible or minor. However, it will take importance when analysing the power supply given by the electric motor of the dolly, but the study is provided on its relevant WP.
The aerodynamic tests for the trailer may not vary a lot from the ones specified for trucks and tractors, and minor adjustments and adaptations could be done to current tests in order to include them.

One of the parts that may be difficult to include to the regulation, is the movable roof designed for the trailer. As the heigh of the roof may vary depending on the load transported by the vehicle, it will not be in the same position normally, so a decision on how it should be tested (what position) would have to be studied.

In order to promote the use such technology and the reduction of CO2 emissions, a good approach for this regulation could be the use of reduced Air Drag value for these vehicles that are equipped with the movable roof. This is an approach that is already been used in different regulations when a certain technology wants to be promoted.

### 3.2.2 UN Regulation No. 58: Uniform provisions concerning the approval of Rear Underrun Protection Devices (RUPDs) and their installation

This regulation establishes the requirements for the certification of Rear Underrun Protection Devices, that prevents underrunning of vehicles to the back of the truck or trailer. Recently, this regulation has also introduced requirements for aerodynamic devices given that more and more vehicles are including this technology on their rear part. Therefore, it is important to take a look on these changes in order to evaluate them and consider if there is the need to recommend new provisions.

The new amendment of the regulation introduces a new annex focussed on aerodynamic devices and its testing provisions. The purpose of the tests is to verify whether the aerodynamic device, in the event of a collision with the rear of vehicle or the vehicle combination, is compromising the rear underrun protection. Some general specifications apply to all the aerodynamic devices affected by the regulation, and they are summarised below:

- The external part of the device shall not exhibit any pointed or sharp part that could increase the risk or seriousness of bodily injury to a person hit by the external surface or brushing against it in the event of a collision.
- Additionally, the external surface shall not exhibit any part likely to catch vulnerable road user.
- The radius of curvature of the protruding parts of the aerodynamic device shall not have a radius of curvature less than 2,5 mm.
- These parts protruding of the external surface, may have a radius of curvature less than 2,5 mm if they are made of a material of hardness not exceeding 60 shore A.

The tests described for the aerodynamic devices, may be performed through four different methods:

1. On the vehicle for which the device is intended to be fitted.
2. On part of the body where the device is intended to be fitted.
3. On a rigid wall.
4. Simulation by calculation[8]

The regulation specifies that the devices fitted in the back of the vehicle, shall offer a certain level of deformation when forces are applied parallel to the longitudinal axis of the vehicle, or may also be folded under the application of the force. The force shall be applied to the device with a surface of not more than 250 mm in height and 200 mm wide as it can be seen in Figure 10.

[8] For the simulation method, in is important to remark that the mathematical model used for this calculation shall be previously validated through comparability with real tests.

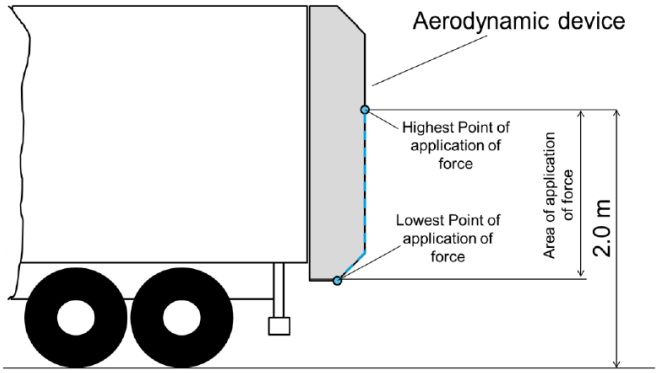


**Figure 10. Test procedure of aerodynamic device**

The specified force is 4000 N ± 400 N, that shall be applied consecutively to two points situated symmetrically to the centre line of the vehicle on the rearmost outer edge of the aerodynamic device when completely unfolded.

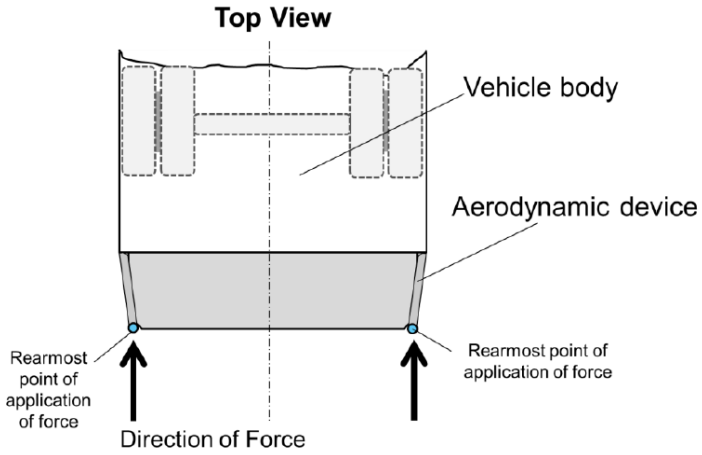


**Figure 11. Top view of the test procedure.**

The test is considered valid if the aerodynamic devices have, at the point of application, an elastic or plastic deformation with a maximum remaining length of 200 mm in the longitudinal direction of the vehicle. If the device is folded when the forces are applied, the test is deemed to be satisfied too.

***Recommendations***

New modifications of the regulation cover almost completely the devices introduced by the project, by adding tests and new provisions in terms of the safety of the vulnerable road users. However, some clarifications to the regulation shall be made, in order to be more specific on which vehicles the regulation applies.

More specifically, the regulation nowadays does not apply to tractive units for articulated vehicles. For the purpose of this project, that foresee different combinations, for example: truck-dolly-semitrailer, if the truck is considered tractive unit, the regulation would not apply to it. This case would not be beneficial, as the truck could also operate alone, so the conditions for the aerodynamic devices should also apply.

Another item that should be studied is the movable roof of the trailer, in case it is also fitted with a roof boat tail. It may occur that for the lower positions of the movable roof, the boat tail position could endanger the other road users in case of accident. In the case that this position is lower than 2 meters, then the same test applied for the side aerodynamic devices should also be performed to the boat tail. This would ensure that the aerodynamic device is folded or deformed when certain force is applied to it, improving the safety of the other road users.

### 3.2.3 UN Regulation No. 10: Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

Even if not relevant changes are expected to UN Regulation No. 10, the inclusion of aerodynamic devices shall take into account this regulation when electric transmission is used. Then, for all these active devices intended to be installed on the vehicle, this regulation applies at the time of type approval.

### 3.2.4 UN Regulation No. 73: Lateral protection devices (LPD)

This regulation stablishes the requirements for lateral protection devices (LPD) and thus, it plays an important role for this work package, because the vehicles are fitted with side skirts that reduce the aerodynamic drag and improve the fuel consumption. The scope covers all the vehicles of the combination (both category N3 and trailers), but excludes tractors for semitrailers, where it is not possible to install such device for practical reasons.

The certification procedure for these devices, may vary depending on if the device is directly installed on the vehicle, or it is firstly approved as a technical unit that can be installed on the vehicle afterwards.

According to the definition of lateral protection, structural parts of the vehicle such as fuel tanks, metallic parts… may be used as LPD as long as the part is able to fulfil the requirements defined along the regulation. For the project, it is assumed that the side skirts installed on the vehicle shall be able to perform such function.

In case that the aerodynamic devices are intended to be fitted to different vehicles instead of a particular vehicle, we must focus on the approval of the LPD as a separate part.

The list of the following requirements shall be fulfilled for all the devices, installed on the vehicle, that will act as lateral protection:

- The outer surface of the LPD shall be smooth, and if possible, continuous from front to rear.
- The forward edge shall consist of a continuous vertical member extending over the whole height of the device.
- The device shall be essentially rigid and made of metal or any suitable material. It is considered suitable if is able of withstanding a horizontal static force of 1 kN applied perpendicularly to any part of the external surface. It may be demonstrated through calculation by the manufacturer.
- If the lateral protection is designed to have different positions at the side of the vehicle, there must be a secure method to fix it, so that any unintentional change of position is avoided. In this case the force applied by the operator to vary the position of the device shall not exceed 40 daN.

Considering the abovementioned requirements, current designs of the aerodynamic devices may fulfil all of them without relevant changes to the text, because the provisions are open enough to allow its inclusion.

Once the devices are approved as a separate unit, other requirements have to be followed during the installation on the vehicle:

- The device shall not increase the overall width of the vehicle, and the main part of its outer face shall not be more than 150 mm inboard from the outermost plane of the vehicle.
- For N3 vehicles, the position of the device shall be not more than 300 mm to the outer surface of the tyre on the wheel immediately forward of the device.
- For semitrailers, not more than 250 mm to the rear of the transverse median plane of the support legs.
- The lower edge of the LPD shall not be more than 550 mm above the ground.
- The upper edge of the LPD shall not be more than 350 mm below the structure of the vehicle.

***Recommendations***

Overall, the current provisions and requirements for the lateral protection devices, are quite aligned with the proposed solutions as aerodynamic devices. However, there are specific parts of the regulation that should be adapted in order to completely accept the solutions developed within the project:

- The proposed side skirts are devices that cover all the side extension of the truck or trailer, in contrast with current LPD, that do not cover the space of the wheel. The aerodynamic devices cover this space, because the drag coefficient is better than the cases where it is not covered.
  This implementation can lead to devices that protrude some millimetres outside of the width of the vehicle (which currently is not accepted by the regulation). Therefore, it may be necessary to approve new exemptions on the LPD that are also intended for aerodynamic improvement of the vehicle.

According to that, there is the need to analyse the safety distance between the wheels and the aerodynamic devices, taking into account the heat dissipation of the brakes using the devices. It may also be necessary to perform some of the tests of UN Regulation No. 13 (Braking systems) using the LPD as worst case, during the fade test for example.

### 3.2.5 UN Regulation No. 13: Braking provisions to M, N and O vehicles (High – Vehicle)

Un Regulation No. 13 and the design of the braking systems is not directly affected by the use of aerodynamic devices, as explained in the evaluation of UN Regulation No. 73 (Section 3.2.4). Nonetheless, the use of certain devices, like lateral protection devices, might cause a different behaviour of the braking performance. This is due to the coverage of the wheel causing the air flow around the braking system to be heavily reduced which can lead to a lower heat dissipation of the drum or disk brake. Heat dissipation is related to braking performance in the way that, if the temperature in the brakes is high (i.e. after a long downhill) the heat dissipation is very low, and therefore the braking performance is reduced.

***Recommendations***

As vehicles fitted with side skirts would be a worst case in terms of braking performance and heat dissipation, the text should include that if vehicles are intended to be fitted with such devices, the Type I test (fading test) should be performed with the devices mounted on the vehicle. The test procedure would remain equal, but the usage of the devices during the hot performance would cause a major impact to the final temperature of the brakes, and a worst performance. Additionally, the regulation should also be modified for type II and type II-A tests, which are also performed with hot brakes after continuously braking during 6 km at a 6 % downhill grade. These tests should be done with the aerodynamic devices fitted.

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

In terms of the steering system, the inclusion of the aerodynamic devices, developed within the scope of the project, do not affect the system itself. Provisions and requirements of this regulation are focused on the robustness of the design of the steering system, and how to test it (mainly checking the effort and the manoeuvrability). Lately, the regulation has begun to include ADAS systems, that provides assistance to the driver on following the lane, avoiding obstacles, and park the vehicle.

At this point, there are ADAS functions which the operation with rear boat tails could endanger the other road users' safety and would need to be revised or analysed. Trucks may be fitted with a system called ACSF A, a function that is able to operate at speeds no greater than 10 km/h to assist the driver in low speed or parking manoeuvring.
In addition to the las system, there is also another ADAS system that would be affected by the use of the devices. The ACSF C is a system fitted on vehicles, that can perform a single lateral manoeuvre (lane change) when commanded by the driver. In this case, the use of the devices does not imply big changes to the general requirements of the function, however, the system is designed to operate taking into account the distance between the rear part of the truck and the vehicle that is approaching from the rear in the adjacent lane.

Finally, there are specific tests required only for trailers, with the aim to evaluate that the trailer travels without excessive deviation from the towing vehicle, that would need to be re-evaluated when tested with the rear devices.
The regulation defines a test in order to verify the area swept by the trailer in a curve, when the towing vehicle is travelling at different speeds. It is clear that the use of rear extensors on the vehicles would hamper the

manoeuvrability of the combination, hence, recommendation in that area could be done in order to not penalize the use of these technologies (in a similar way as it has been done in regulation for masses and dimensions).

***Recommendations***

As a first step, according to the above explanation, there is a need to re-evaluate the operational domain and burdens for the ADAS systems, when the vehicle is fitted with rear aerodynamic devices. The boat tail extensions may add 500 mm to the total length of the vehicle, a distance that is not currently taken into account on the design of the ACSF systems. Additionally, sharp edges of the tails can cause injuries to vulnerable road users. For that reason, the recommendation is as follows:

- To include a clause that would not allow the use of the system when the boat tail extensions are in active position. This way, it is ensured that the system operates in a safe mode, and rear distances are correctly calculated according to the real length of the truck.

Regarding changes or recommendations on the ACSF Category C system, amendments would be minor, in order to adapt the added length to the truck:

- The regulation defines a way to calculate the minimum distance and minimum operation speed. In this case, it would be as easy as adding the length of the rear boat tail extension (500 mm maximum) to the formula provided in the regulation. This solution would increase the safety distance between the truck and the approaching vehicle considering the devices installed in the rear part of the vehicle.

For the manoeuvrability of the trailer, first of all is necessary to understand what is being required for trailers with regards to its deviation when moving at different speeds. As example, the regulation defines the following test:

*""6.3.2. With the towing vehicle and trailer having adopted a steady state turn corresponding to a turning circle radius of 25 m (see paragraph 2.4.6.) at a constant speed of 5 km/h, the circle described by the rearmost outer edge of the trailer shall be measured. This manoeuvre shall be repeated under the same conditions but at a speed of 25 km/h ±1 km/h. During these manoeuvres, the rearmost outer edge of the trailer travelling at a speed of 25 km/h ±1 km/h shall not move outside the circle described at a constant speed of 5 km/h by more than 0.7 m."*

So, the maximum difference between the swept area by the rearmost outer edge of the trailer at 5 km/h and 25 km/h is set at 0.7 m.

- Given that the addition of extensions at the rear of the trailer would lead to an increase of the swept are, it probably would penalize vehicle fitted with them. One option could be to not test with the devices deployed, so the limit would be equal, or to modify the text and allow to not consider the rearmost outer edge of the trailer, but the rearmost edge without taking into account the tail extensions.

### 3.2.7 UN Regulation No. 121: Uniform provisions concerning the location and identification of hand controls, tell-tales and indicators

The use of controls, tell-tales and indicators is very useful for the drivers, as long as they are aware of the conditions of the vehicle every moment. It is not desired a high number of tell tales, nor non harmonized tell tales and signals that can be misleading by the drivers. For that reason, UN Regulation No. 121 unifies and harmonizes the controls, tell tales and indicators that are considered important for safety reasons.

***Recommendations***

As the aerodynamic devices may need controls for its deployment positions when driving and tell tales to indicate the operational status every moment, there is the need to introduce such definitions and characteristics to the text of the regulation.

The regulation should define a control for the use of the active aerodynamic systems, and a tell-tale that could warn the driver of the operational status, as it is shown in Figure 12.

| No. | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|---|---|---|---|---|---|
| | Item | Symbol [2] | Function | Illumination | Colour |
| 1. | Master lighting switch<br>Tell-tale may not act as the tell-tale for the position (side) lamps |  1, 18 | Control<br>Tell-tale [12] | No<br>Yes | <br>Green |

**Figure 12. Table including symbols, their illumination and colours**

### 3.2.8 UN Regulation No. 105: Uniform provisions concerning the approval of vehicles intended for the carriage of dangerous goods with regard to their specific construction features

Given the high importance of the safety in vehicles that are intended for the transport of dangerous goods, the inclusion of the aerodynamic devices in such vehicles shall be analysed carefully.

For this reason, there are already some provisions that shall be taken into account for all these devices:

- For aerodynamic devices that uses electrical equipment, the installation shall be so designed, constructed and protected that it cannot provoke any unintended ignition or short-circuit under normal conditions of use of vehicles.
- The cables shall be in conformity with standard ISO 6722-1:2011 including its Corr. 01:2012 or ISO 6722-2:2013.

## 3.3 WP4 - Smart loading units (SML)

The aim of WP4 is to investigate the potential to improve transport efficiency by developing and applying smart and flexible solutions for load optimization and efficiency of long vehicle combinations as well as the multimodal aspect.

### Final solutions implemented

The results presented by this WP in deliverable 4.3 have different solutions, based on three concepts, to be incorporated in the demonstrator of the project.

Concept 1 - Multimodal flexibility and compatibility
The flexible Loading Unit must fit to the most relevant handling techniques to switch from road to rail in this concept. The solution presented is equipped with many innovations for load efficiency improvements and aerodynamic features. The goal is to prove that these innovations also allow the transport of the trailer by train. Therefore, this trailer was technically changed by VanEck like adding gripping pockets, active side skirts, fixing the aerodynamic devices for moving backwards and a many more.

Concept 2 - Loading space efficiency
This concept has two different proposed solutions:

1. **Puzzle software**
   Used to implement optimization for
   - How many pallets (volume/weight) allowed per Trailer
   - Where to put each pallet (loading plan)
   - Find the optimized floor position of the double floor
2. **CargoCam**
   Used to improve load optimization, efficiency, and vehicle aerodynamics and transport efficiency. It focuses on the development and demonstration of new technologies, concepts and architectures for the calculation of the trailer's space and contained cargo volume. Knowing the real cargo hold and height profile of the trailer volume enables many other use cases as the introduction of smarter systems, which can combine data and information in a smart way to generate higher benefit and improve transport efficiency. For instance, a trailer roof transformation system could use the height profiles to adjust the roof shape and thereby improve aerodynamics. A warehouse smart loading system could use the data of the PUZZLE system and of the CargoCam to improve and assure correct loading schemes.

Concept 3 - Modularisation - Horizontal collaboration:
The concept prepares for automated loading and unloading of trucks in future due to modularisation. It uses the Puzzle software to load efficiently the trailer and make a test plan to improve the route and the times of the travel.

# Matrix

| | | *Relevance* | *Vehicle* | *Use* | *Infra.* |
|---|---|---|---|---|---|
| UNECE | UN R10: Electromagnetic compatibility (EMC) | High | X | | |
| | UN R73: Lateral protection | Medium | X | | |
| | UN R155: Cyber Security | Medium | X | | |
| | UN R156: Software Updates | Medium | X | | |
| EU directives & regulations | Regulation (EC) 1230/2012: Masses and dimensions | High | X | X | X |
| | Regulation (EU) 2018/858: Framework Regulation on Approval and market surveillance | Medium | X | | |

| | | | | | |
|---|---|---|---|---|---|
| | Regulation (EU) 2019/1213 On-board weighing equipment | Medium | X | | |
| Standards | UIC 571-4: Wagons in combined Transport | Medium | | | X |

Table 3 shows the updated matrix with those regulations that affect the solutions implemented within WP4.

| | | *Relevance* | *Vehicle* | *Use* | *Infra.* |
|---|---|---|---|---|---|
| UNECE | UN R10: Electromagnetic compatibility (EMC) | High | X | | |
| | UN R73: Lateral protection | Medium | X | | |
| | UN R155: Cyber Security | Medium | X | | |
| | UN R156: Software Updates | Medium | X | | |
| EU directives & regulations | Regulation (EC) 1230/2012: Masses and dimensions | High | X | X | X |
| | Regulation (EU) 2018/858: Framework Regulation on Approval and market surveillance | Medium | X | | |
| | Regulation (EU) 2019/1213 On-board weighing equipment | Medium | X | | |
| Standards | UIC 571-4: Wagons in combined Transport | Medium | | | X |

**Table 3. WP4 regulatory matrix (updated according to implemented solutions)**

### 3.3.1 UN Regulation No. 10: Electromagnetic compatibility (EMC)

As explained previously (Section 3.1.1 and 3.2.3), this regulation applies to all the vehicles, components and separate technical units intended to be fitted in these vehicles. The CargoCam Software use an Infrared 3D sensor and telematic units where they can cause problems with incompatibility to the current system mounted or the new generation of automated trucks.

***Recommendations***

All the components what intervenes on the CargoCam, or the other different software with the same purpose, shall be developed following the UN R10. Mainly due to future problems that this can made to, for example, to fulfil the Regulation (EC) 1230/2012: Masses and dimensions, the trailer have a sensors to calculate the mass loaded and because of this malfunction the mass finally exceeds the maximum allowed. Also, it can affect to function of the e-Dolly and may will have problems with the control system.

### 3.3.2 UN Regulation No. 73: Lateral protection

This regulation establishes the requirements for lateral protection devices (LTD). The solution adopted about the grippers could be regulated at UN Regulation No. 73.

***Recommendations***

As explained in deliverable 4.3, the grippers are fitted with pockets welded in the chassis (as it can be seen in Figure 13).

**Figure 13. Pockets welded in the chassis with push out strip**

As explained at the definitions of the regulation ""*Unprotected road users" means pedestrians, cyclists or motor cyclists using the road in such a way that they are liable to fall under the sides of the vehicle and be caught under the wheels*". For these reasons, the dimensions of the pockets need to be prescribed so that they don't become a danger for any road user. The dimensions between the two elements could be defined to have at all different sites the same type of working tools.

### 3.3.3 UN Regulation No. 155: Cyber Security

The United Nations presented this new Regulation to improve and regulate the Cyber Security applied to all the elements what can be attacked by others.

Currently, the solutions developed for the WP does not interact directly with the systems of the vehicle, thus the use of them would not directly impact with the security of the vehicle. However, it is important to take into account that, if in a future extension of the proposed solutions, there is an interaction with the OBD port or any of the IT vectors of the vehicle, then the systems will have to be developed following the prescriptions of Regulation 155 on cybersecurity.

### 3.3.4 UN Regulation No. 156: Software Updates

The Software Updates Regulation goes at the same direction as the Cyber Security Regulation, if the trailer is fitted with the UN Regulation No. 155 and this need to have a Software Updates, this shall fulfil with the new UN Regulation No. 156.

Similar to Regulation 155, this regulation would only affect the proposed solutions in case that the software is directly implemented inside the vehicle. In such case, the software version and integrity, shall be recorder by the manufacturer in order to assess traceability of the implemented changes and updates performed during the lifecycle of the vehicle. This process ensures that the vehicle fulfils the requirements of the software update-related systems that are likely to be type approved.

### 3.3.5 Regulation (EC) 1230/2012: Masses and dimensions

This Regulation lays down the requirements for the EC type-approval of motor vehicles and their trailers with regard to their masses and dimensions as well as of certain separate technical units intended for those vehicles.

For this part is important to focus on the masses of the trailer and how it will be loaded to each axle.

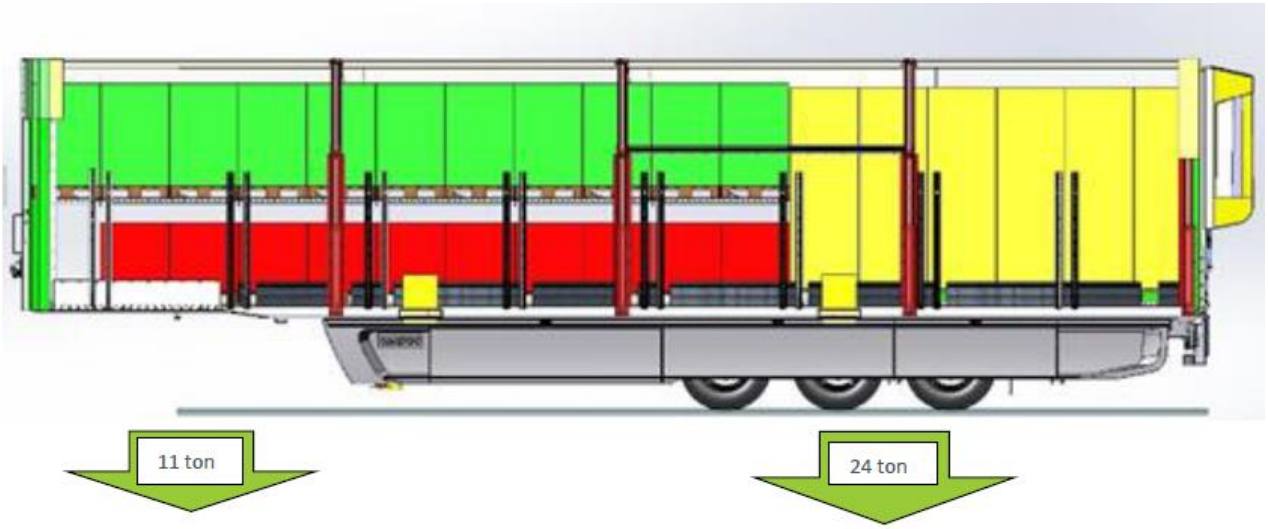


**Figure 14. Indication of weight on the king pin and axles in certain configuration**

***Recommendations***

Although this regulation is not directly affected by the proposed solutions, given that the document defines maximum lengths and masses for specific categories of vehicles, it would be desirable the implementation of systems (coupled with onboard weighting systems) able loading processes of the vehicles in order to ensure efficiency but also to avoid overloading.

### 3.3.6 Regulation (EU) 2019/1213: On-board weighing equipment

The On-board weighing equipment helps the driver to know how the vehicle and trailer are loaded. The process between the sensors of the load and how the information is transmitted to the driver screen are defined.

***Recommendations***

To follow the new Regulations about Cyber Security (UN Regulation 155) and the Software Updates (UN Regulation 156), the information referred on weigh needs to be subjected to this regulation. Especially the manufacturers that use the Stage 2 OBW.

A Stage 2 OBW means: The information between motor vehicle and the trailers or semi-trailers being towed shall be exchanged by means of C-ITS stations.

The coupling of OBW systems with the solutions of the AEROFLEX project, can lead to a more efficient way of loading, given that the live data of each axle may be verified at any time, and optimised to obtain the best efficiency without overloading the vehicle or any of the axles.

### 3.3.7 UIC 571-4: Wagons in combined Transport

In order to facilitate and speed up transport in a reliable manner, a coding system for various elements of combined transport was established. The system ensures safe operation of ITUs, indicates their loading gauges, and ensures the owner is identified[9].

***Recommendations***

It is important to identify the double floor trailers because the weight distribution can be different as how it is known now. At 2.5 Semi-trailers, a new value can be added to this mark to know the different type of trailer it is used.

[9] https://uic.org/IMG/pdf/guide_du_tc_en.pdf

### 3.4 WP5 - Innovative Front End Design for more Safety (IFEDS)

WP5 has developed a new concept for the front-end design of trucks (cabs over the engine) considering three aspects: passive safety, active safety and aerodynamics. The aim of this work package has been to increase the safety for vulnerable road users (VRUs) and to ensure the security for the occupants of other vehicles without risking the security of the own truck occupants, all of this while reducing the energy consumption.

Regarding passive safety three areas of the vehicle have been differentiated: the crash area between passenger cars and trucks, the VRUs' protection area, and the truck occupants' area. For the front area, changes in the material have been done in order to improve the safety of the VRU in case of impact. The thickness and the distance from hard points of the external skin have been reduced to minimize the injury level. The extra volume obtained from the elongation of the front-end has been filled with crash absorbers with the aim of dissipating energy during a crash event.

On the other hand, active safety has been also improved by enhancing a better front visibility from the driver's position, by maximizing the windshield area to guarantee direct visual detection of VRUs. In addition to the modification of the windshield, the different possibilities for installing different active safety systems have been studied. The systems analysed for the new front-end design are: Autonomous Emergency Braking (AEB), Side Guard Warning (SGW) and Lane Support Systems (LSS).

The last modification that has been made is related to the vehicle's aerodynamics. The external shape of the cab has been built to maximize the aerodynamic performance. The front-end has been extended around 500 mm forward and the edges have been rounded and smoothed compared to a current 4x2 tractor architecture truck.

## General Safety Regulation analysis

This section makes an overview of the new General Safety Regulation (GSR) (EU) 2019/2144 focussing on the parts of the regulation that involve the front area of the trucks. This new regulation, compared with the previous one R(EC) No. 661/2009, is focused on two new fields: protection of vehicle occupants and protection for vulnerable road users (VRUs). For this project, the interest resides on the vulnerable road users and its requirements. In the preamble of the new GRS, related to the WP5 studies, there are two points of interest:

**1.**

*"10) ….. Advanced emergency braking systems, intelligent speed assistance, emergency lane-keeping systems, driver drowsiness and attention warning, advanced driver distraction warning and reversing detection are safety systems that have a high potential to reduce casualty numbers considerably. In addition, some of those safety systems form the basis of technologies which will also be used for the deployment of automated vehicles. Any such safety systems should function without the use of any kind of biometric information of drivers or passengers, including facial recognition. Therefore, harmonised rules and test procedures for the type-approval of vehicles as regards those."*

As it has been mentioned in this chapter's introduction, Active Safety Systems are necessary in terms of avoiding a possible collision. The latest regulations included in the new General Safety Regulation, concerning ADAS systems, which are applicable to trucks, are listed below:

- UN Regulation No. 131 - Advanced Emergency Braking System (AEBS)
- UN Regulation No. 151 - Blind Spot Information System (BSIS)
- UN Regulation No. 159 - Moving Off Information System (MOIS)
- An European regulation for Intelligent Speed Assistance is pending to be approved in a near future.

The first regulation mentioned above (R131) is already mandatory for new types and for new registration. The other three regulations (R151, R159 and Intelligent Speed Assistance) are going to be mandatory for new types from 6th July 2022 and for new registrations from 7th of July 2024.

**2.**

*"22) …Historically, Union rules have limited the overall length of truck combinations, which resulted in the typical cabover-engine designs as they maximise the cargo space. However, the high position of the driver led to an increased blind-spot area and poorer direct visibility around the truck cab. This is a major factor*

*in truck accidents involving vulnerable road users. The number of casualties could be reduced significantly by improving direct vision. Requirements should therefore be introduced to improve direct vision to enhance the direct visibility of pedestrians, cyclists and other vulnerable road users from the driver's seat by reducing to the greatest possible extent the blind spots in front and to the side of the driver. The specificities of different categories of vehicles should be taken into account."*

The maximum permitted length and the poor direct visibility are some of the key factors that the WP5 had to deal with.

## Masses and dimensions analysis

Regarding the maximum permitted length, the regulations that limit the length of the trucks are:

- **Directive (EU) 2015/719**: this directive sets the maximum dimensions for international traffic. However, the Member States can restrict certain vehicles in some specific cases; for reasons related to road safety or infrastructure characteristics, the circulation of certain vehicles in specific part of the road network… This directive, grants derogations on the maximal lengths to make heavy goods vehicles greener by improving their aerodynamic performance. These rules (Directive (EU) 2015/719 and the Member State's regulations) are complemented by the requirements for type-approval of commercial vehicles, especially Regulation (EU) 1230/2012, last amended by Regulation (EU) 2019/1892.

- National and local regulations of each Member State.

Regulation (EU) 2019/1892 stablishes the requirements for motor vehicles that are fitted with elongated cabs and it specifies which conditions shall a vehicle comply to be considered an elongated cab:

*"4)…With a view to ensuring coherence between EC type-approval legislation and the harmonised rules for road vehicles circulating within the Union, it is necessary to lay down type-approval requirements for motor vehicles with elongated cabs and for aerodynamic equipment or devices in order to ensure that they provide benefits in terms of energy performance, better visibility for drivers, safety to other road users as well as safety and comfort for drivers."*

As a first approach, the new front-end design can be considered an elongated cab as it improves the visibility and increases the safety of other road users, especially vulnerable road users, by ensuring better direct vision and a bumper that is more impact-friendly.

## Direct Vision analysis

Regarding the poor direct visibility of the cab, there are two new regulations that make mandatory (from 6th July of 2022 to new types and from 7th July of 2024 for new registrations) to install advanced systems in order to tackle the problem about the lack of vision, and prevent accidents with vulnerable road users.

- The regulation for Blind Spot Information System, UN Regulation No. 151 (date of entry into force 15/11/2019)
- The regulation for Moving Off Information System, UN Regulation No. 159 (date of entry into force 10/06/2021).

Another regulation that addresses the visibility of the cab is UN Regulation No. 46. This regulation has the aim of trying to solve the lack of direct vision by using indirect vision devices. In addition, in order to improve the visibility, the VRU-Proxi (GRSG) is working on a regulation regarding Direct Vision. The regulation regarding Direct Vision for heavy duty vehicles is going to be mandatory for new types from 7$^{th}$ January of 2026 and for new registrations from 7$^{th}$ January 2029.

## Matrix

After the general analysis provided above, this chapter will focus on the specific regulations that affect the cab, in terms of the front-end design.

| | | Relevance | Vehicle | Use | Infra. |
|---|---|---|---|---|---|
| UNECE REGULATIONS | UN R29: Protection of the occupants of the cab | High | X | X | |
| | UN R43 : Safety glazing material | Medium | X | | |
| | UN R93: Front Underrun protective devices (FUPD) | Medium | X | | |
| | UN R121: Tell-tales and indicators | Low | X | X | |
| | UN R131: Advanced Emergency Braking System (AEBS) | Low | X | | |
| | UN R151: Blind Spot Information System (BSIS) | Low | X | | |
| | UN 159: Moving Off Information System (MOIS) | Low | X | | |
| EU directives & regulations | Regulation (EU) 19/2011 : Manufacturer statutry plate and VIN | Low | X | | |
| | Regulation (EU) 1230/2012: Masses and dimensions | High | X | X | X |
| | Directive (EU) 2015/719: Masses and dimensions in international traffic | High | X | X | X |

**Table 4. WP5 regulatory matrix (updated according to implemented solutions)**

### 3.4.1 UN Regulation No. 29: Protection of the occupants of the cab of a commercial vehicle

The regulation aims at protecting the occupants of the cab of a commercial vehicle (N category vehicles). There are three tests that have to be done for a cab-over the engine. Test A where the front part of the vehicle is tested against frontal impact in order to assess the resistance of the cab in frontal impact accidents. A second test, Test B, where the front pillar is tested against front impact. And the third test, Test C, that aims at testing the roof's strength.

Test A is meant to be performed for cab-over-engine vehicles. When the regulation was developed, the shape of cab-over the engine used to be square, so vehicles with the new front-end designs were not considered eligible to be tested. With the new front-end designs, the main issue that will have to be addressed in the regulation is related to the impactor. The impactor used now fits properly with the windshield and the bumpers of traditional cab-over engine vehicles (as it can be seen in Figure 15).

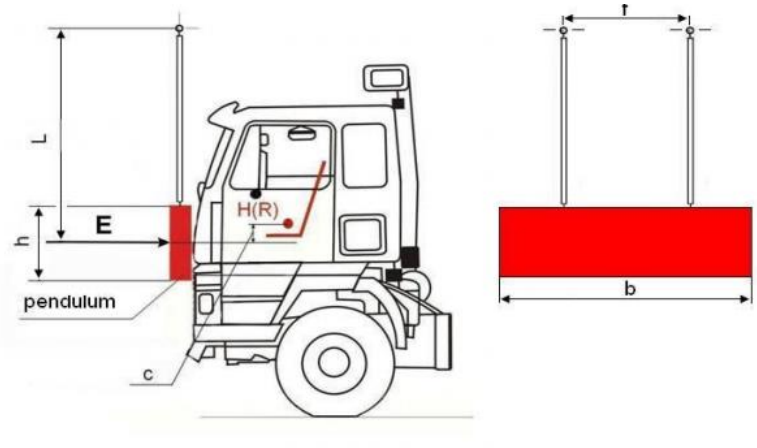


**Figure 15. Front impact test (Test A)**

With the new design, the windshield is bigger and, therefore, the impactor will impact against the glass which is not meant to happen in test A. In addition, the windshield and the bumpers have been tilted and, therefore, testing with the current impactor won't be adequate due to its surface that don't adapt to most of the front shape (as it can be seen in Figure 16).

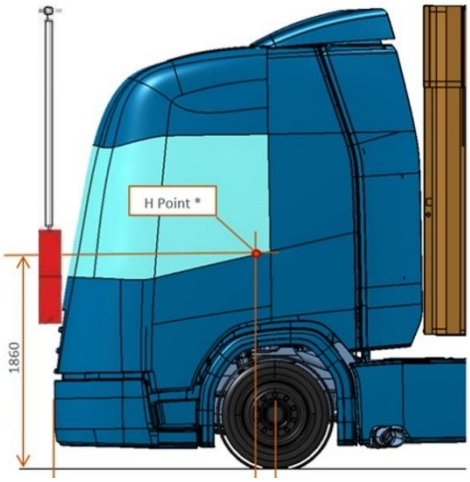


**Figure 16. Front impact test (Test A) for new front-end design cabs.**

***Recommendations***

As it is mentioned above, the current test is designed in a way that the new cab might not be able to be tested properly due to the shape of impactor. Therefore, a first step towards the deployment of these new concept of more aerodynamic and safe cabs, the regulation shall be modified to redesign of the impactor in order to make possible to adapt it to different front cab shapes.

### 3.4.2 UN Regulation No. 43: Safety Glazing Materials

The regulation is about safety glazing and their installation on vehicles in order to ensure a high level of safety for the occupants and also to provide the driver with a high degree of visibility in all traffic conditions. This regulation defines the characteristics of the glazing. For the case of the AEROFLEX cab, the importance resides on the new windscreen, due to the modification of the front-end design.

According to the head's impact study made in WP5, with the new front-end design, there are head impacts that may occur in the windscreen area due to the elongated windscreen, which does not happen in conventional trucks. Head impact against glass causes more damage than against a steel bonnet as the simulation performed shows.[10] That is why it is important to use laminated safety glass in the windscreen, in order to protect the pedestrian in case of accident. In the same study, to reduce even more the damage of head impacts, the way that the windscreen is fixed to the vehicle might help absorbing energy.

***Recommendations***

UN Regulation No. 43 only defines the characteristics of each glazing, but it does not include the way that the windscreen is fixed to the vehicle. The study made by WP5 regarding the way that the windscreen is fixed demonstrates that: if the glued line of the windscreen is hidden by the bonnet side and, if some energy absorbers are introduced between the windscreen line and the bonnet, the injury of VRU's heads is reduced. So, it would be positive to add in the regulation some specific requirements for the proper installation of windscreens, which would minimize the severity of an injury in case of a VRU being hit by the truck.

### 3.4.3 UN Regulation No. 93: Front Underrun Protective Devices (FUPD)

This regulation is about the Front Underrun Protective Devices (FUPD). The regulation defines that N2 and N3 category vehicles must fit a FUPD in order to avoid the underrunning of M1 or N1 vehicles in case of a frontal collision. The requirements regarding the installation of the devices are according the height, the ground clearance and the width, of the FUPD. Therefore, this regulation has to be considered, by the manufacturer, when designing an elongated cab. Structure have to be designed, with the correct measures, in order to be fixed properly to the chassis and comply with the regulation's requirements. It is not foreseen that this regulation needs to be adapted due to the introduction in the market of elongated cabs.

[10] AEROFLEX – Deliverable D5.3 "Virtual demonstator" - https://aeroflex-project.eu/downloads-2/

### 3.4.4 UN Regulation No. 121: Tell-tales and indicators

The regulation is about the tell-tales and indicators that are displayed on the dashboard, metercluster, displays, screens or any other devices intended to inform the driver the current state of the vehicle systems or to inform what is the function of each device.

The introduction of new ADAS regulations brings new tell-tales and indicators. So, in order to clearly identify each tell-tale or indicator, the upcoming tell-tales and indicators will have to be designed to avoid confusions between them.

***Recommendations***

With the introduction of new ADAS systems, there are some tell-tales or indicators that are not listed in UN Regulation No. 121 yet. Some examples are the tell-tale intended for the Blind Spot Information System or for the Moving Off Information System. Therefore, the regulation should be updated to include the newest ADAS systems' tell-tales.

### 3.4.5 UN Regulation No. 131: Advanced Emergency Braking System (AEBS)

Distractions and lack of attention provoke accidents very often. To avoid some of those accidents, AEBS is being equipped in the vehicles in order to brake the vehicle when the system detects that a collision is going to be unavoidable and the driver does not react. Therefore, it is possible to find two UN regulations, depending on the category that the vehicle belongs to, that address Advanced Emergency Braking Systems (AEBS).

On the one hand, there is UN Regulation No. 131, which covers N2, N3, M2 and M3 vehicles. The scenarios contemplated in this regulation are all related with impacts against another vehicle, either stationary or moving. Therefore, this regulation mainly addresses monotonous highway driving conditions.

On the other hand, a new regulation regarding ADAS has been recently approved (date of entry into force 22nd January 2020), UN Regulation No. 152, which covers $M_1$ and $N_1$ if fitted with these systems. This regulation is meant to cover, urban and highway driving conditions. So, the scenarios that are contemplated not only address collision between vehicles, but also includes scenarios involving collisions between vehicles and pedestrians.

***Recommendations***

Nowadays, GRVA is already working on amendments that will update UN Regulation No. 131 in order to include Vehicle-to-pedestrian scenarios. The manufacturers of cab-over engine vehicles may not have to find problems regarding the installation of the radars and cameras in order to comply with the requirements.

### 3.4.6 UN Regulation No. 151: Blind Spot Information System (BSIS)

UN Regulation No. 151 aims at approving Blind Spot Information Systems for the Detection of Bicycles. The limited field of vision of trucks causes many accidents that involve VRUs. That is why a regulation has been implemented and it is going to be mandatory for N2, N3, M2 and M3 category vehicles (from 6th July 2022 for new types and from 7th July 2024 for new registrations)

When Deliverable 7.1 was written, the topic addressing Blind Spot Information Signal was not a regulation yet. However, nowadays there is a new regulation regarding Blind Spot Information Signals which is, UN Regulation No. 151, consequently, no recommendations are given. However, the new front-end design will have to consider the requirements of both the static tests and the dynamic tests in order to set the sensors, the radars or cameras properly.

### 3.4.7 UN Regulation No. 159: Moving Off Information System (MOIS)

The Regulation (UN) No. 159 aims to approve the Moving Off Information System. The limited field of vision of the heavy-duty vehicles (M2, M3, N2, N3), sometimes leads to collisions against cyclists and pedestrians, having serious consequences for these vulnerable road users. Regulations have been improved and new regulations have been introduced to help the drivers to be aware of their surroundings and to reduce accident rates.

***Recommendations***

The new regulation will require the vehicles to have a system to inform the driver and that system shall be fitted in all the trucks, including the ones with the new front-end design. The Regulation (UN) No. 159 consists in static and dynamic tests. One of the key factors will be the correct setting of the sensors, radars, cameras, and the new front-end design won't have to be a problem to comply with the requirements.

### 3.4.8 Regulation (EU) 19/2011: Manufacturer's statutory plate and Vehicle Identification Number (VIN)

This regulation sets the requirements for the manufacturer's statutory plate and for the vehicle identification number (VIN) of motor vehicles and their trailers. The regulation establishes that the manufacturer's statutory plate must have the following information:

- The manufacturer's company name.
- The whole vehicle type approval number.
- The vehicle identification number.
- The technically permissible maximum laden mass.
- The technically permissible mass of combination.
- The technically permissible maximum mass on each axle listed in order from front to rear.

The Vehicle Identification Number (VIN) is a number of 17 characters and must include the following information:

- The world manufacturer identifier.
- The vehicle descriptor section.
- The vehicle indicator section

There are four models of manufacturer's statutory plate and the model used depends on the category of the vehicle. For instance, the one that is intended to be used on trucks (N2, N3) is the "model B".

***Recommendations***

In order to make it easier to identify if a cab-over the engine is an elongated cab or not, the regulation could add some requirements for the plates so that they included a space dedicated to specify, e.g. with a code, if the cab is elongated or not. This could help identify the type of cab which could affect the regulations it is subject to.

### 3.4.9 Regulation (EU) 1230/2012: Masses and dimensions

Regulation (EC) 1230/2012 aims to stablish the dimensions of each category of vehicles. The new front-end design is affected by two parts of the regulation: the one regarding manoeuvrability and the one affecting dimensions.

Regarding **manoeuvrability**, the current regulation specifies the radius of two circle that the trucks have to be able to turn inside of; an outer circle with a radius of 12,5m and an inner circle with a radius of 5,3m. So, either if a truck is a traditional cab-over the engine or an elongated cab, the actual regulation has the same requirements. This may cause that elongated cabs will have to find solutions such as including Auxiliary Steering Equipment (ASE) on the vehicles where there is more than one steered axle.

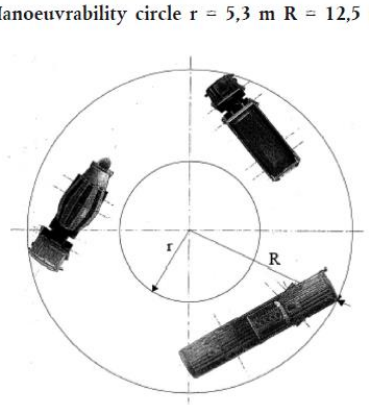


**Figure 17. Manoeuvrability circles**

On the other hand, the elongated cab is also affected by the **dimensions'** requirements established in the regulation. The current regulation, Regulation (EU) 1230/2012, has been amended by the Regulation (EU) No. 2019/1892 where some extended requirements for elongated cabs have been included. Originally, for a N3 category vehicle, the maximum permitted length was 12 metres, however, with the new amendment this length can be exceeded if the vehicle complies with two requirements:

1. The loading area doesn't exceed 10,5 m
2. The three-dimensional envelope is as set out in Appendix 5 of Annex 1. The three-dimensional envelope is a boundary that if a vehicle fits in (including all the external projections, such as the chassis, bumper, wheel guards and wheels), then the vehicle(N2,N3) can be considered as elongated cab. The Appendix stablishes the following requirements:
    a. The vertical boundaries of the motor vehicle cab assessment zone.

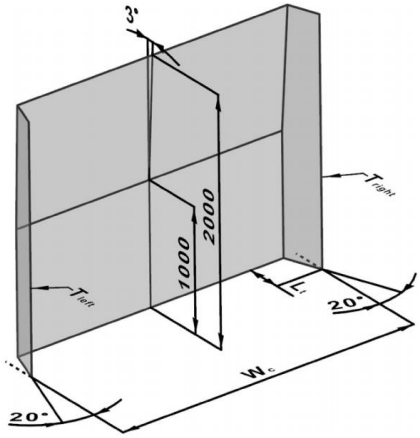


**Figure 18. 3D envelope**

    b. Horizontal boundaries of the motor vehicle cab assessment zone.

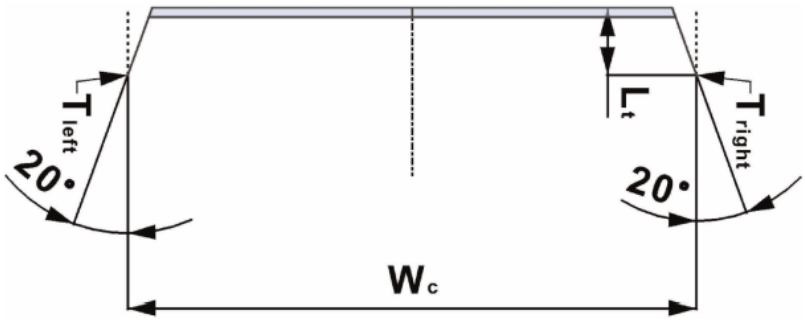


**Figure 19. 3D envelope plan view**

    c. Specific provisions for motor vehicle cab assessment zone, such as the rake of the front of the cab and tapering of the sides of the motor vehicle cab.

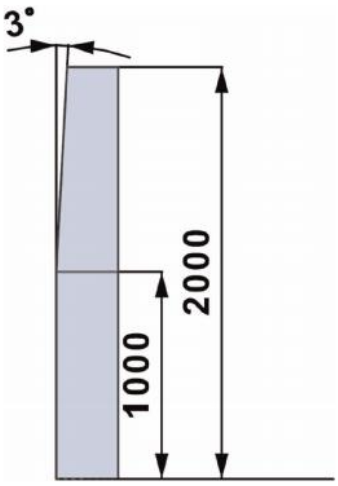


**Figure 20. 3D envelope lateral view**

***Recommendations***

For elongated cabs, “manoeuvrability circles” can be hard to perform (the circles of r =5, 3m and R=12,5 m), so for future amendments the regulation shall consider softer requirements for that type of cabs.

### 3.4.10 Directive (EU) 2015/719: Masses and dimensions in international traffic

Directive (EU) 2015/719 aims to modify the current Directive 96/53/EC in order to adapt it to the new technological developments and changing market needs and to facilitate intermodal transport operations. The amendments on the Directive 96/53/EC are focused on three main topics:

- The increase of the maximum authorized length.
- The increase of the maximum authorized weight.
- The implementation of controls to detect infractions in the previous topics.

The first topic is the one that has an effect on this project. One of the reasons that sponsor the increase of the maximum length is the new front-end design of cab which makes the vehicle longer and reduces the space for the load.

Nowadays, the maximum length permitted for travelling in European roads is 12 meters for motor vehicles, 16.50 meters for articulated vehicles and 18.75 meters for road train. The lengths mentioned before collide with the requirements of the last amendment of the Regulation (UE) 1230/2012 introduced (Regulation (EU) No 2019/1892), which specifies that the “cab-over the engine” can be considered as elongated cabs and so be longer than 12 meters. In that cases the Directive (EU) 2015/719, which is previous to Regulation (EU) No 2019/1982, don’t consider the requirements for elongated cabs). So, that means that a truck with “the new front-end design” can be approved according Regulation (UE) 1230/2012 with more than 12m length, but it cannot be driven by European roads.

# PART C:
# Future recommendations on Access to infrastructure

# 4 Intelligent Access Policy (IAP)

## 4.1 Context

Despite recent pandemic situation, the society is on the longer term confronted with a high demand for mobility of both people and freight, which are constantly growing. Individual mobility for people is still highly present in people's behaviour. However, the multimodal transport of the freight is still not well developed on global level in Europe.

Considering the current numbers, logistics represents around 10-11% of global CO2 emissions, around 90% of which come from freight transport. The dominant mode for inland freight transportation in Europe is the road, which accounts for a share of approx. 75% as can be seen in Figure 21.

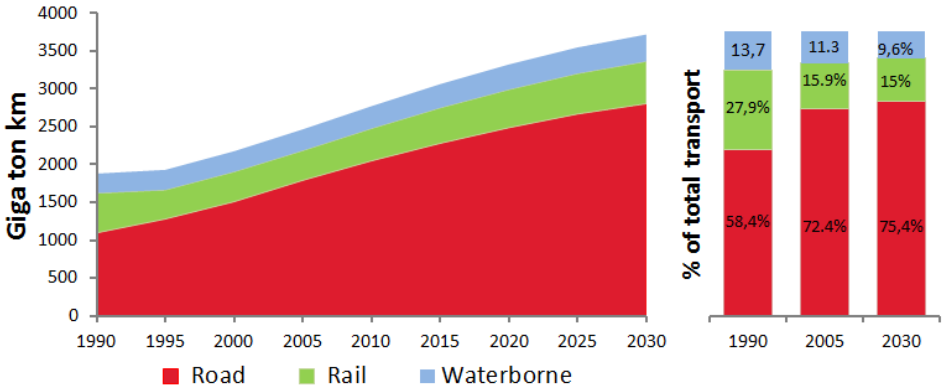


**Figure 21. Transport demand prognosis[11]**

Moreover, as can be seen in Figure 21, the road segment will remain a dominant transport mode in EU in the future with the highest energy consumption, and therefore biggest impact on the environment and society. According to the International Transport Forum/OECD[12], global CO2 emissions from the movement of freight could more than double by 2050 unless radical new policies supporting new technologies and vehicles are adopted. As identified in AEROFLEX project, these vehicle concepts and new technologies must support interconnection with all transport modes and usage of renewable energy to achieve considerable impact on emissions reduction. Above all, the better usage of the infrastructure potential is essential. This will lead to a seamless coverage of all reachability levels such as confined areas, hub to hub, open connections, and urban environment with vehicles that combine all available transport and fit the needs of a specific operational environment such as depicted in Figure 22.

[11] European Commission, Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, Brussels, 2011

[12] OECD/ITF, High-Capacity Transport: Towards Efficient, Safe and Sustainable Road Freight, 2019

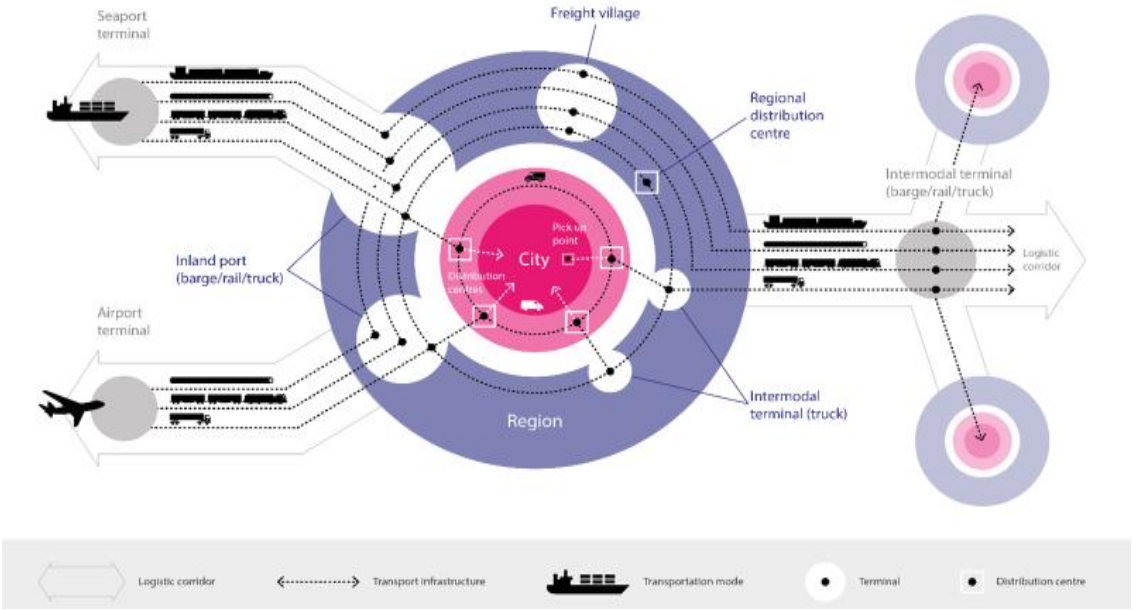


**Figure 22. Schematic structure of intermodal transport**

In the context of the road freight transport sector one of the main obstacles for the implementation and deployment of new technologies and vehicles concepts is the legislation. As proved by many Research & Innovation projects within the framework of EU funded programs (e.g., TRANSFORMERS, FALCON, ENSEMBLE, ASSURED, ...etc.) it is often hard or even impossible to implement the results because of missing legislation that would carry the innovations and thus we may lose the positive impact they could potentially have on economic, environmental, and societal aspects.

To build the bridge towards the deployment for the new types of vehicles and smart loading units in terms of legislation we propose implementation of Intelligent Access Policy (IAP) to the infrastructure for heavy vehicles. Even though such a form of legislative framework was not yet adopted in Europe (contrary to e.g. Australia) is appears to be the logical extension of already existing UVAR (Urban Vehicle Access Regulation) program that is widely supported by European Commission[13].

Hence, in this chapter we firstly explain the fundamentals of the Intelligent access policy, furthermore we identified a number of stakeholder clusters which are seen crucial for the adoption of IAP, which were approached and consulted on multiple levels. The findings are presented in the endo of this chapter along with more specific vision how the IAP can be implemented in the Europe to substantially enhance road freight transport efficiency.

## 4.2 Intelligent Access Policy fundamentals

### 4.2.1 Current situation

The access of road freight vehicles to the majority of European infrastructure is conditioned by the compliance with European directive 96/53EC, last amended by directive (EU) 2015/719, which sets strict limits on the weight and dimensions of vehicles and loading units. This results to higher extent in polarization of the access that is either granted to the global infrastructure network or is fully restricted. Subsequently, this leads to the oversimplified situation which does not allow to use the full potential of the European infrastructure through accurate matchmaking between the vehicle combination abilities and specific segments of the infrastructure. Moreover, it restricts the introduction of new vehicle concepts and technologies which do not comply with directive 96/53/EC because of, for example, excessive length.

**There is a need to create awareness being flexible and adaptable by using new intelligent standards and protocols that fit to the digital age we are living in.**

[13] Project ReVeAL, https://civitas-reveal.eu/

### 4.2.2 IAP based foresight

A feasible approach that may facilitate the deployment of the new generation road freight vehicles, listed specifically in "Transport efficiency potential of EMS vehicles using logistics Use-cases"[14], whilst ensuring the operational safety and compatibility with the infrastructure and the environment is the Intelligent Access Policy, known also as Performance Based Standards[15], which controls the access of the road freight vehicles to the specific segments of the infrastructure.

The idea of intelligent vehicle access is supported by the European Parliament through recent preparatory action called Urban Vehicle Access Regulation. Herewith, the emphasis is to establish a form of a traffic management system that regulates access to specific urban areas and locations. Access is conditioned by a vehicle type, age, or emission category for a specific time of the day or day in the week, for example as practiced in NORDICWAY project[16]. This ensures improvement in urban living environment, more flexible traffic management that is highly effective and beneficial for the clean mobility as shown in Figure 23a).

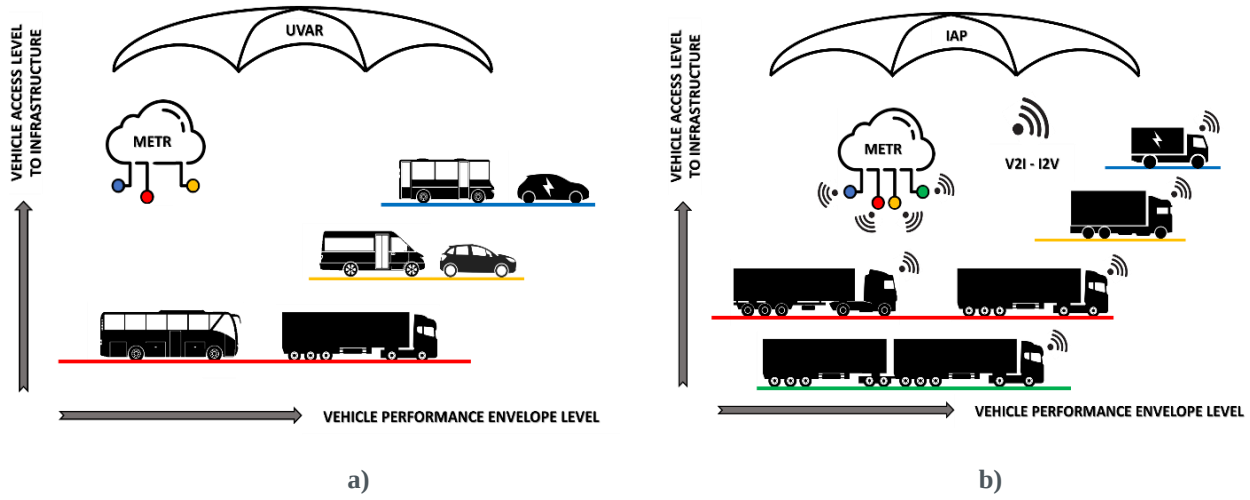


**Figure 23. a) Urban Vehicle Access Regulation (UVAR) and b) Intelligent Access Policy (IAP).**

The control of Vehicle Access may be ensured through the Management for Traffic Regulation (METR) being the system supported by the European Commission. Besides the UVAR pilot programmes which are aiming primarily on enhancement of urban mobility, similar-like approach of Intelligent Access Policy can be upscaled and adopted for the road freight transport as proposed in Figure 23b).

Hereon, the infrastructure network can be categorized into several access levels as depicted in Figure 18b), with four different colour lines representing four access levels. The infrastructure level would depend mainly on properties such as for example:

- Average annual daily traffic
- Lane and/or bridge width
- Accident history
- Cornering space and road slope
- Other road users, parked cars, cyclists…. etc.

[14] E. van Eijk, G. Koorneef, S. Wilkins, P. Mentink, Aeroflex – Transport efficiency potential of EMS vehicles using logistics Use-cases, Proceedings of the HVTT16, Qingdao, China, 2021

[15] K. Kural, Analysis of high capacity vehicles for Europe: application of performance based standards and improving manoeuvrability. Doctoral dissertation, Technische Universiteit Eindhoven, 2019

[16] Nordic Way project, www.nordicway.net

Resulting in road level categorization such as Highway Corridors, Main arterial Roads, Local Roads, and Urban Areas. Subsequently, every vehicle or combination of vehicles can be assessed in terms of a vehicle performance envelope. Herewith, the performance envelope can be described as a set of behaviour that is related to for example:

- Low-speed manoeuvrability
- Dynamic stability
- Environmental impact
- Infrastructure impact…etc.

At the last instance, the matchmaking between the infrastructure segments which are classified with certain access levels and the vehicle performance envelope will be accomplished. As shown in Figure 18b), this will result in the framework which is able to accommodate new generation of road freight vehicles on dedicated segments of network such as the spine of European multimodal freight network corridors TEN-T (depicted in green). Moreover, it will prevent vehicles with poor environmental or manoeuvrability performance to enter the infrastructure at urban areas (depicted in blue). Thus, the level of the performance envelope of a vehicle, or combination of vehicles, is used as a conditional criterion to access the segments of an infrastructure that are of equal level or lower. Generally, it means that a vehicle combination which has performance envelope level 2, can operate on infrastructure segments classified as level 1 and level 2. Contrary to existing UVAR's, the proposed IAP can additionally accommodate continuous real-time communication between the vehicles and the METR which may dynamically control the access of all vehicles participating in the scheme to the infrastructure. Furthermore, METR will monitor the vehicle compliance with access criteria using the principles of geofencing and ensuring such the vehicle performance envelope matches the capability and current state of the infrastructure. Thus, data which may be shared by the vehicles with METR may include for example vehicle real-time position or the weight carried per axle, which is seen by road authorities as highly desirable to prevent the overloading of vehicle combinations.

The IAP concept may be also applicable beyond the road freight transportation and fits highly to the future of Automated Driving (AD) domain. Herewith, the IAP may matchmake an access to vehicles equipped with AD technology to the infrastructure segments through C-ITS Dynamically Controlled Zones according to the vehicle Operational Design Doman (ODD) and AD readiness level.

## 4.3 User groups definition

As explained in previous section, IAP primarily ensures matching the performance and characteristics of a road freight vehicle with the state and capability of specific section of infrastructure network.

This is beneficial primarily for:

- Vehicle operators which may gain the efficiency in the transport process by using new vehicles, technologies, and optimised routing.
- Road authorities which can continuously monitor the loading state of vehicles and enforce the infrastructure is not overloaded by road freight vehicles.
- Society which will benefit by reduced emissions form the road freight and better usage of infrastructure that will reduce the congestions which is beneficial in multiple dimensions.

Based on this reasoning, and to successfully deploy the Intelligent Access Policy in the future, 5 clusters of stakeholders have been identified, which will mutually interact to serve the society as shown in Figure 24.

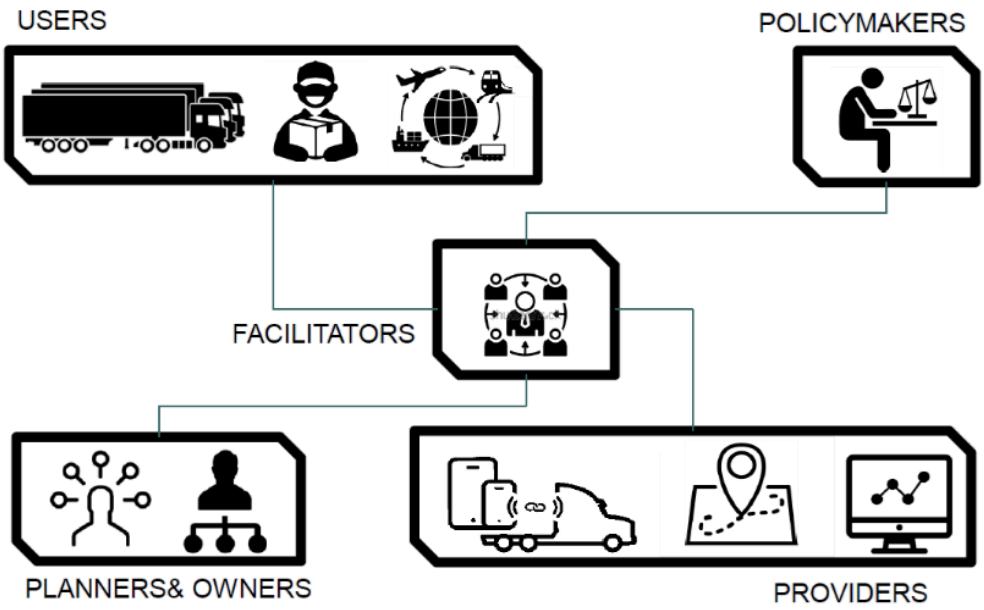


**Figure 24. IAP Stakeholder Clusters**

The identified stakeholder clusters are as follows:

- USERS – represented by the transport companies, fleet owners, logistic service providers, shippers, other road users, and users of other modes.
- PROVIDERS – represented by the companies/institutes, offering systems and tools (such as maps to telemetry) to execute IAP and METR.
- POLICYMAKERS – policymakers, vehicle regulators, and (safety) certification authorities on European, national, and regional level.
- PLANNERS & OWNERS – responsible for building and maintenance of infrastructure (road/ rail/ water/ air/ tube).
- FACILITATORS – companies, institutes, research centre bringing stakeholders together and facilitating pilot projects.

As a part of the AEROFLEX project extensive research was done (see Figure 25) among more than 30 interviews with persons who were affiliated with one of the identified stakeholder clusters (i.e. users, providers, facilitators, policymakers, planners & owners). The goal of the interviews was to understand the needs of each cluster, to identify what are the barriers and success factors for the implementation of IAP, and/or what can be used as opportunity to deploy the IAP in Europe. Subsequently, four workshops were held (in a quiz format) in order to validate and discuss interview findings with 19 stakeholders. Next, a common view on IAP was developed (by collaboratively writing the IAP newspaper – which can be found in Annex 1) in two concluding workshops, with 12 stakeholder participants in total. Lastly, in the final workshop stakeholders were given the opportunity to validate the findings of the previous steps. In each of the stages of the process participants iteratively reviewed and reflected on findings and statements in the preceding stage. As such it was possible to validate and refine the views on IAP. In the next section we summarize the aggregated learnings from this stakeholder consultation process.

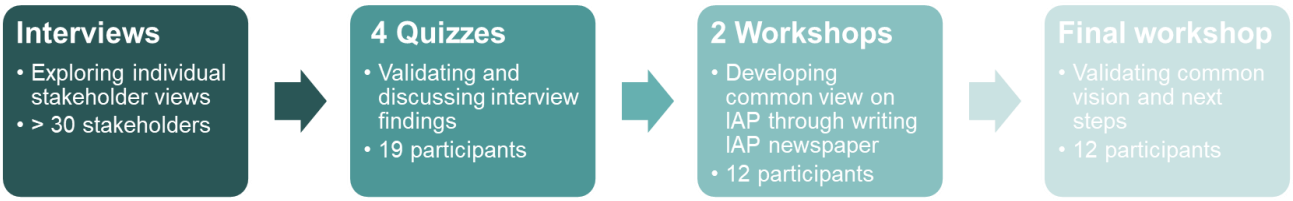


**Figure 25. Stakeholder Consultation Process**

## 4.4 Stakeholder needs and success factors for implementing IAP

The learnings acquired from the stakeholder consultation process can be split into two groups being the stakeholder needs per cluster and success factors for the deployment and implementation.

### 4.4.1 Stakeholder Needs

**a) General needs of the Society**

a. The awareness of IAP on pan-European level needs to be created through webinars, knowledge and technological platforms, and European research and innovation projects.
b. One of the biggest challenges identified for the global implementation is the harmonization of policies and infrastructure design codes among all 27 EU jurisdictions. Hence the preferred approach in Europe should be bottom-up, while including national base pilots which are scalable.
c. The local, national-based pilot projects dedicated to roll out/test various concepts of IAP, needs to be scalable for further expansion.

**b) Users**

a. It has been agreed upon the stakeholder cluster of users that IAP can significantly contribute to enhancement of the logistic process through better ability to plan, forecast, and interact with other transport modes.
b. Impose minimal additional cost for the Users IAP (logistic service providers) related to hardware and software which will be required to run the framework on the vehicle side, otherwise the risk of rejecting the scheme by Users exists. In simple terms the IAP it needs to be cost effective or profitable for Users.

**c) Providers**

a. Telematics providers should work together to develop linkages/Application Programming Interfaces between the various systems so the right data can be disclosed. Also, in this case, the work needs to be motivated by clearly defined business case to develop IAP platforms and services.

**d) Policymakers**

a. Policymakers need to act as frontrunners who should support small local (national based) pilots, and homologation of new vehicles and vehicle technology.

**e) Planners and owners**

a. IAP can be used as tool for road authorities which can better monitor the real load pattern of the pavement and bridges. This can be used not only as a protection of the infrastructure, but also as a tool to plan the infrastructure maintenance more optimally.

**f) Facilitators**

a. The role of the facilitator is seen crucial for gaining the trust of all involved stakeholders. Therefore, it is important that facilitator will be independent, yet with a solid mandate which is supported by policymakers and government.
b. Establish solid governance structure for the national-based facilitators, as they will be primarily in charge of running the IAP schemes.

### 4.4.2 Success Factors

**a) IAP needs to act as enabler towards other developments:**

a. A common agreement exists throughout the all-stakeholder clusters that **IAP can be a great enabler towards $CO_2$ footprint reduction** from road freight transport. Thus, should be linked to action plan of the EC named EU Green Deal (which endeavours to reduce the $CO_2$ emissions of road transport by 30% by 2030). This is completely different point of view compared to Australia, where the main incentive for the implementation of IAP was productivity.

b. IAP can serve not only as enabler towards the deployment of vehicles which have mass and/or dimensions beyond current regulation, but also to **speed-up implementation of new technology** such as electric/hybrid vehicles, automation or teleoperation which may impose specific requirements on the infrastructure such as, charging stations availability, mobile network signal quality, etc.

**b) Data exchange**

a. **Data exchange** between the stakeholders is essential to deploy the IAP framework. It can be illustrated on cluster of Users which is foreseen to share some high-level data (as e.g. loading state and GPS location) with the road planners & owners to guarantee the compliance of a vehicle with the infrastructure. Simultaneously the Users, may be hesitant to so, as such data is being considered sensitive. Therefore, the data protection and governance are extremely important. Furthermore, should be mentioned that sharing the data should be in general rewarded with some privileges for the users.

b. **Integrity for monitoring and exchanging the data** is essential for the trust of logistic operators in the User cluster. Moreover, the data accessibility needs to be managed well (perhaps even partially anonymized) without compromising the security or competitiveness of all involved stakeholders.

## 4.5 Recommendations on the next steps towards deployment

In the last two stages of the stakeholder consultation process (Figure 25), forming a common view on the next steps was an important aspect. In iterative rounds, through constantly reviewing and reflecting, it was possible to develop a common vision for the steps towards deployment of IAP (see Figure 26). It should be noted that these steps are not exhaustive, rather provide insights in the most important milestones as identified by the various stakeholder groups.

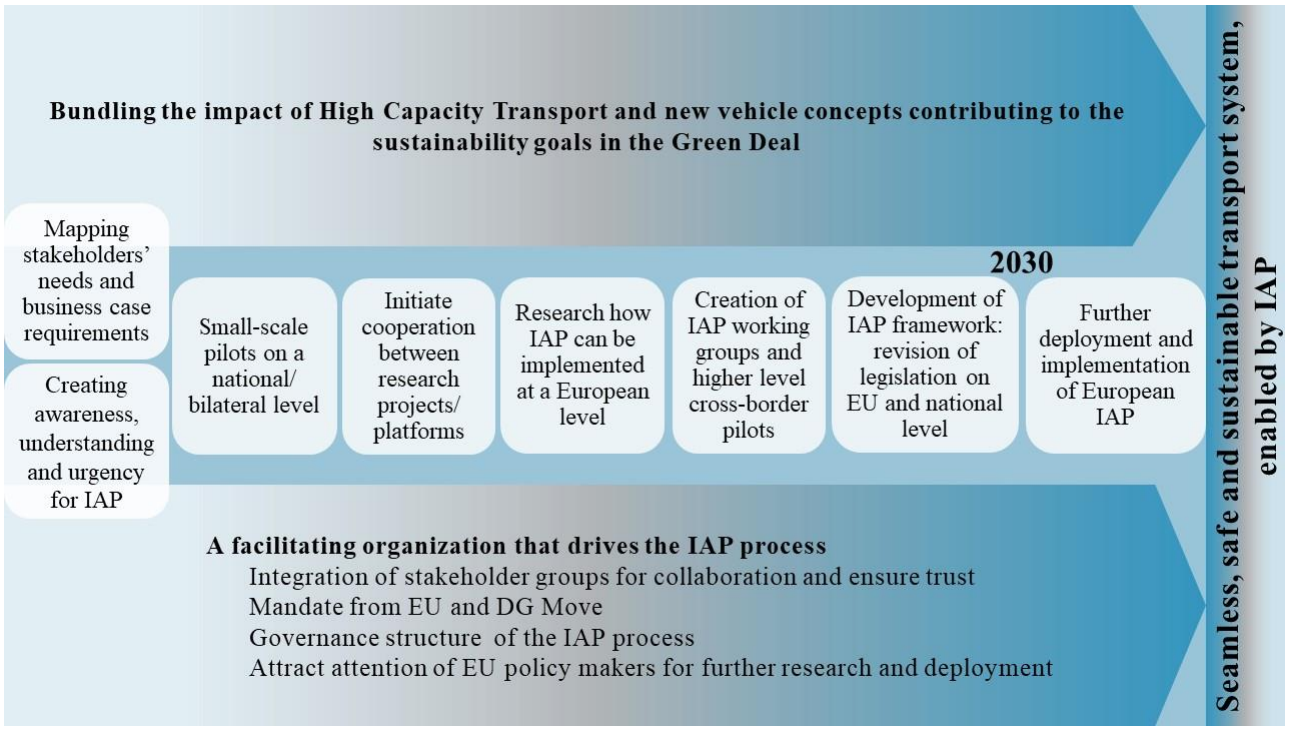


**Figure 26. Steps towards deployment of IAP**

The common vision is composed of three elements:

1) The ultimate **objective** being *A seamless, safe, and sustainable transport system, enabled by IAP*. As stated in the introduction of this chapter, there is a need to enhance road freight transport efficiency and sustainability in Europe, and IAP can be one of supportive means to achieve this overarching objective.

2) Two **supportive processes**:
   a. *Bundling the impact of High-Capacity Transport and new vehicle concepts contributing to the sustainability goals in the Green Deal*. As identified as a success factor, the development of IAP can contribute to and create synergies with ongoing efforts to reach the sustainability goals in the Green Deal. All stakeholders agree that IAP can facilitate the usage of more efficient and sustainable vehicle concepts along the roads in Europe.
   b. *A facilitating organization that drives the IAP process*. Also, this supporting process is deemed to be crucial for IAP development, based on the listed stakeholder needs. As multiple parties with varying objectives and perspectives are needed for developing IAP, an independent facilitator can bring these stakeholders together and ensure trust among them. Also, the facilitator can ensure mandate from the European Union and DG move. Next to that the facilitator can also set up and support the governance structure of the IAP process. Lastly, the facilitating organization(s) can attract attention of EU policymakers to stimulate further research and development. Collaboration across stakeholder groups is considered to be for IAP contributing to a seamless, safe and sustainable transport system. The following major steps have to be taken.
3) The **major steps** to be taken:
   a. It all starts with *mapping stakeholder needs*, understanding their perspective and identifying requirements for their business cases. This goes along with *creating awareness* and a sense of urgency among these stakeholders that IAP development is essential for contributing to a futureproof transport system that is both efficient and sustainable.
   b. Next, through a bottom-up approach *small-scale pilots on national and bilateral levels* should be set-up. Through continuous learning, experience can be gained in (cross-border) collaboration for matching vehicle characteristics with the state and capability of the infrastructure network.
   c. In order to accelerate the development of IAP throughout Europe, *cooperation between research projects and platforms* is crucial for exchanging knowledge and international learning. As such pilots can build on the experiences of previous initiatives and do not have to "reinvent the wheel".
   d. Combining the insights from these projects, *research on how IAP can be implemented on a European level* is needed to bring it from national/ bilateral level to a framework that is applicable throughout Europe.
   e. In addition to the previous step, *IAP working groups and higher-level cross-border pilots* will contribute to the development of a European framework for IAP.
   f. Then, actually *developing the IAP framework and revising current legislation*, both on national and European levels is required in order to embed the learnings of the previous steps in a legislative system that is effective and can be enforced.
   g. It can be expected that with all stakeholder efforts will ensure that IAP development is well on its way by 2030. It is needed though, to continuously evaluate whether IAP contributes to the overarching goal of a safer, more efficient, and sustainable transport system. Consequently, also beyond 2030 all stakeholders have to continue working on *further deployment and implementation of European IAP.*

With this common vision of the next steps, there is a hope an important start is made for the development of Intelligent Access Policies for a future-proof transport system in Europe that is safe, efficient, and sustainable.

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| | *Group or Organisation* | *Document* | *Web Site Documentation* |
|---|---|---|---|
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| 2 | UNECE – GRBP | GRBP Informal working groups and documents | https://wiki.unece.org/pages/viewpage.action?pageId=917781 |
| 3 | UNECE – GRE | GRE Informal working groups and documents | https://wiki.unece.org/pages/viewpage.action?pageId=2523229 |
| 4 | UNECE – GRPE | GRPE Informal working groups and documents | https://wiki.unece.org/pages/viewpage.action?pageId=917779 |
| 5 | UNECE – GRSG | GRSG Informal working groups and documents | https://wiki.unece.org/pages/viewpage.action?pageId=2523225 |
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| 7 | UNECE – GRVA | GRVA Informal working groups and documents | https://wiki.unece.org/pages/viewpage.action?pageId=63310525 |
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| 9 | European Commission | Road Infrastructure Charging – Heavy Goods Vehicles | http://ec.europa.eu/transport/modes/road/road_charging/charging_hgv_en.htm |
| 10 | ITF-OECD | Permissible maximum dimensions of lorries in Europe | https://www.itf-oecd.org/weights-and-dimensions |
| 11 | ITF-OECD | Permissible maximum weights of lorries in Europe | https://www.itf-oecd.org/weights-and-dimensions |

## 5.2 Regulations/Directives

| | *Title* | *Web Site Documentation* |
|---|---|---|
| *1* | UN R10: Electromagnetic compatibility EMC | https://www.unece.org/trans/main/wp29/wp29regs1-20.html |
| *2* | UN R13: Braking provisions to M, N and O vehicles | https://www.unece.org/trans/main/wp29/wp29regs1-20.html |
| *3* | UN R29: Protection of the occupants of the car | https://www.unece.org/trans/main/wp29/wp29regs21-40.html |
| *4* | UN R34: Fuel system safety (Fuel tanks protection) | https://www.unece.org/trans/main/wp29/wp29regs21-40.html |
| *5* | UN R43: Safety glazing materials | https://www.unece.org/trans/main/wp29/wp29regs41-60.html |
| *6* | UN R48: Installation of lighting and light-signalling devices | https://www.unece.org/trans/main/wp29/wp29regs41-60.html |
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| *9* | UN R58: Rear underrun protection | https://www.unece.org/trans/main/wp29/wp29regs41-60.html |
| *10* | UN R73: Lateral protection | https://www.unece.org/trans/main/wp29/wp29regs61-80.html |
| *11* | UN R79: Steering equipment | https://www.unece.org/trans/main/wp29/wp29regs61-80.html |
| *12* | UN R93: Front underrun protection devices | https://www.unece.org/trans/main/wp29/wp29regs81-100.html |
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| *17* | UN R131: Advanced Emergency Braking System (AEBS) | https://www.unece.org/trans/main/wp29/wp29regs121-140.html |
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| | | |
|---|---|---|
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| *44* | UIC 596-6: Codification system in combined transport | https://infostore.saiglobal.com/en-gb/standards/uic-596-6-ed-6-2014--1712532/ |
| *40* | UIC 571-4: Wagons in combined Transport | https://infostore.saiglobal.com/en-gb/standards/uic-571-4-ed-6-2014--1712530/ |

## 5.3 Regulatory Framework general concepts

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| | | |
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Project partners:

| # | Partner | Partner Full Name |
|---|---|---|
| 1 | MAN | MAN TRUCK & BUS AG |
| 2 | DAF | DAF Trucks NV |
| 3 | IVECO | IVECO S.p.A |
| 4 | SCANIA | SCANIA CV AB |
| 5 | VOLVO | VOLVO TECHNOLOGY AB |
| 6 | CRF | CENTRO RICERCHE FIAT SCPA |
| 7 | UNR | UNIRESEARCH BV |
| 8 | SCB | SCHMITZ CARGOBULL AG |
| 9 | TIRSAN | TIRSAN TREYLER SANAYI VE TICARET A.S. |
| 10 | CREO | CREO DYNAMICS AB |
| 11 | MICH | MANUFACTURE FRANCAISE DES PNEUMATIQUES MICHELIN |
| 12 | CHALM | CHALMERS TEKNISKA HOEGSKOLA AB |
| 13 | DLR | DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV |
| 14 | FHG | FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. |
| 15 | HAN | STICHTING HOGESCHOOL VAN ARNHEM ENNIJMEGEN HAN |
| 16 | IDIADA | IDIADA AUTOMOTIVE TECHNOLOGY SA |
| 17 | NLR | STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM |
| 18 | TML | TRANSPORT & MOBILITY LEUVEN NV |
| 19 | TNO | NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO |
| 20 | MHH | MEDIZINISCHE HOCHSCHULE HANNOVER |
| 21 | UIRR | UNION INTERNATIONALE DES SOCIETES DE TRANSPORT COMBINE RAIL-ROUTE SCRL |
| 22 | WABCO-NL | WABCO AUTOMOTIVE BV |
| 23 | WABCO-DE | WABCO GMBH |
| 24 | VET | VAN ECK TRAILERS BV |

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# Annex

# 7 Annex 1

This annex includes the Intelligent Access Policies newspaper which its contents have been developed within the project in a series of interviews, quiz sessions and workshops on IAP with various stakeholders. This newspaper can be also found on the project website.[17]

[17] https://aeroflex-project.eu/newsflash-2030-looking-back-at-the-driving-forces-behind-the-success-of-the-intelligent-access-policies-in-the-early-2020s/

# THE INTELLIGENT ACCESS POLICIES

*NEWS BULLETIN*

**June 2030**

AEROFLEX

## Safe and efficient transportation of freight

## Ensure Equitable Access of Vehicles to the Infrastructure by Digitalization

**Started back early in the 2020ies, AEROFLEX achieved its goal: ensuring the right truck with the right cargo at the right time on the right road, by 2030. How? Through actively starting the development of Intelligent Access Policies and introducing it step-by-step throughout Europe.**

The European consortium AEROFLEX developed high capacity vehicle technologies and innovations to improve transport efficiency up to 33%. The energy savings were huge and an absolute necessity in order to make the essential steps towards zero emissions in 2050. However, at the time these efficient vehicles were not allowed on the EU roads (except for in a few Scandinavian and Spanish regions). Getting these vehicles on the roads was of the greatest importance and as one transporter put it at the time: *"These vehicles must be part of the solution, we are letting ourselves and future generations down if we do not use all possibilities, we have to cut emissions".*

## Inconsistent policies

In the 2020ies, vehicle access to the majority of European infrastructure was conditioned by the compliance with European directive 96/53/EC, last amended by directive (EU) 2015/719, which set strict limits on the weight and dimensions of vehicles and loading units. Among the 27 jurisdictions this resulted in widely inconsistent policies and polarization of access: access was either granted or fully restricted. For international transport, these inconsistent policies were a major bottleneck for introducing more efficient and sustainable vehicle concepts, let alone smooth and efficient transport.

*For international transport, these inconsistent policies were a major bottleneck for introducing more sustainable vehicle concepts*

## Optimally matching vehicle and infrastructure

One might mistakenly think that in 2020 everyone pushed to get high capacity vehicles allowed on every road in Europe. However, learning from Australia, Europe developed a policy system that optimally matched vehicle concepts with the infrastructure: Intelligent Access Policies (IAP). Through European rules and local applications, IAP ensured harmonization of vehicle performance access criteria at an EU level, while at the same time allowing local flexibility (by using real-time data) to ensure vehicle access where appropriate. For example, in Gothenburg where one of first IAP systems was developed out of series of consecutive projects called NORDICWAY.

Thus, IAP contributed to allowing access of new types of vehicles, with capabilities matched with the infrastructure (e.g. maximum possible load, possible turning circles and real-time traffic). As such, these vehicles fit in a multimodal system, where the optimal transport mode could be chosen based on cargo and infrastructure characteristics.

*Crucial in the development of IAP was keeping the ultimate goals in mind: improving on sustainability and safety of the transport and mobility system for everyone*

## Stakeholder involvement was key

Crucial in the development of IAP was keeping the ultimate goals in mind: improving the sustainability, efficiency and safety of the freight transport system. Strong stakeholder involvement was key in this process. As we will show in the following pages, a broad range of stakeholders was repeatedly consulted: from policymakers and planners such as infrastructure managers to community and society. Together these groups brought us to where we are today: supporting process of seamless multimodal freight transport that is sustainable, efficient and safe for the industry, society and planet.

# Six stakeholder groups: the driving force behind the IAP success

## Users - starting with U of union, IAP brought them together

Different users, such as transport companies, logistics service providers and shippers, had different expectations and goals. However, they had one thing in common: they all were hesitant to share data and were concerned about the privacy of (company) sensitive data. This barrier was overcome by ensuring the anonymity of the shared data. Also, the benefits for this group were emphasized: **by having clear and intelligent access policies international freight transport became more efficient** and procedures for international transport were simplified. As such, better vehicle utilization and cost reduction was achieved.

**IAP created the pathway towards using the appropriate data (e.g. GDPR) whilst ensuring compliance with rules and regulations.**

*Users: Transport companies, fleet owners, logistic service providers and shippers*

## Policymakers - Harmonisation was key

No simple solution is found when talking about policy making; drafting sensible (international) policy is a complex endeavour. There was a clear consensus in the 2020ies on the need for harmonization and for a change in the legislation at all levels, from local, regional, national to European level. The introduction of IAP helped connect different policy goals: accessibility, $CO_2$ reduction, quality of life, health, safety, infrastructure ageing … How? IAP was implemented in different countries. **The benefits at local level allowed policymakers to see the bigger picture** and sense the interest from the rest of the stakeholders group. This encouraged a rulemaking progress to a common **framework on Intelligent Access Policies.**

***Policymakers at a local and global European level, including national vehicle regulators***

## Providers – link pin in the standardization of IAP data exchange


***A Super EcoCombi (SEC) or EMS2-combination with a total length of 32 metres***

At the start of the IAP developments, the providers overcame two main challenges:

1. There were many different Fleet Management (FMS) and Transport Management Systems (TMS), which were mutually incompatible. For implementation of IAP these systems needed to be synchronized to link vehicle characteristics data with infrastructure (and location) data.

2. A lot of vehicles and trailers in the vehicle fleet were not connected at the time. Retrofitting and connecting these to FMS and or TMS was a big challenge at the start of IAP.

**The telematics providers worked together to develop links between the various systems, so that the right data could be collected, stored and disclosed**.

The FMS organizations ultimately found a business case in developing IAP platforms and services. It turned out that IAP was the catalyst for further standardization. This standardization contributed to higher precision-transport (higher quality transport rather than high-capacity transport), policies for electric vehicles, and better application of automated driving systems. On top of that, exchanging information and frequently requesting data became much easier for data infrastructure providers. As a result, **providers were able to improve their efficiency significantly**.

***Providers: Companies and institutes, offering systems and tools to execute IAP such as telematics and data infrastructure***

## Through IAP planners and owners are better able to maintain the infrastructure

Back in the 2020ies, road authorities faced the enormous task of keeping the infrastructure well-maintained within available budgets, while at the same time facing a predicted growth of (road) transport volumes. Through IAP, infrastructure managers were better able to match vehicle characteristics with the infrastructure characteristics. It ensured (by using GPS positions) that each vehicle did not go outside areas where it was not allowed. Transporters shared vehicle data with road authorities for enabling this.

Since trust between parties was a sensitive issue, it was ensured that data was anonymized as much as possible by facilitators. **With the implementation of IAP, road authorities had a tool which enabled them to control traffic in a better way and protect, plan and maintain infrastructure**. Thus, planners and owners have been better able to conduct infrastructure maintenance, reduce costs, and improve safety. Planners and owners reduced maintenance costs while simultaneous contributing to a transport and mobility system that is now safer and more sustainable for all road users and society as a whole.

***Planners and owners: Organizations that are responsible for building and maintenance of physical infrastructure***

## Facilitators – Essential party for connecting stakeholders and ensuring trust among them

In Europe, a comparable model to that in Australia was followed: a neutral facilitating institution played a central role in the development of Intelligent Access Policies. **The facilitator was essential for connecting all stakeholders and ensuring trust among them**. At the start of the IAP process, the lack of trust was an important perceived barrier for many stakeholders.

By a neutral and transparent process, the facilitating organization was able to overcome this barrier. Through the deployment of scalable projects, the trust of all stakeholder groups (a.o., transporters and road authorities) was gained in using IAP as a means for a safe and sustainable mobility and transport system.

***Facilitators: Companies, institutes, or research centers bringing stakeholders together and facilitating pilot projects***

## Community & Society – Perception changed and led to advantages for all

"Trucks are big contaminating monsters!". "I've just bought a motorcycle, what if they don't see me while I drive near them?". "Cities are not meant for trucks; traffic congestion is their fault!" …

These were some of the concerns that the use of IAP has been able to mitigate. Once cooperation amongst stakeholders was achieved, access policies started being introduced. Introduction started at a local level first and expanded until it became possible to cross international borders. Raising awareness of these developments and disseminating the benefits within the community was an important step. **People gained trust, acceptance for high-capacity vehicles, and started seeing the improvements:** less traffic congestion and fewer accidents… Today, now that access policies are implemented and used daily, it is clear that streets and **roads are safer, the air is cleaner** – due to the reduction of pollution – and **fatalities have significantly decreased,** which have brought benefits to the whole society.

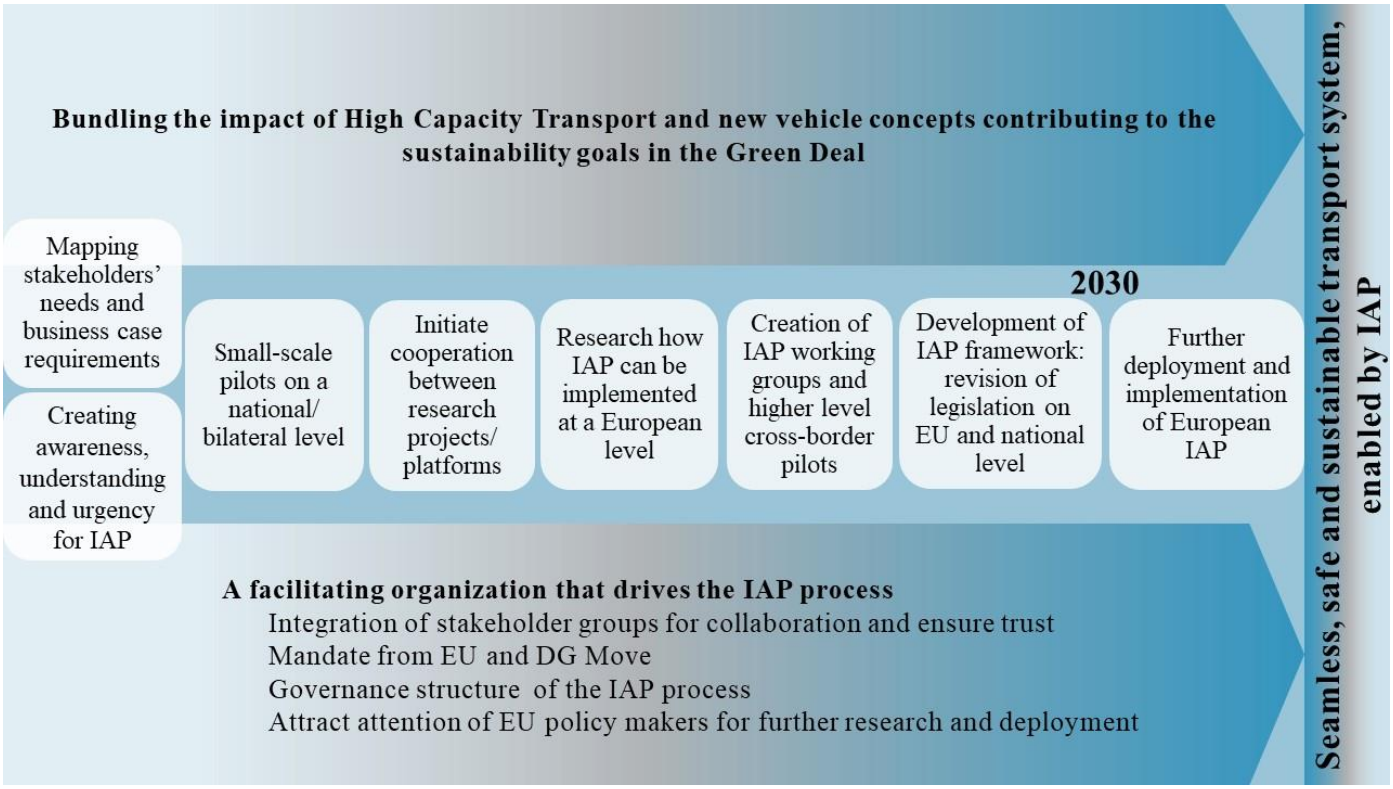
***Community: One diverse crowd!***

AEROFLEX

# Successful Intelligent Access Policies in 2030: Looking back to the 2020ies when it all started

Since the 2020ies – when the developments regarding Intelligent Access Policies started in Europe – major steps have been taken that contributed to today's successes. We cannot stress enough that collaboration across groups was essential for IAP, contributing to a seamless, safe and sustainable transport system.

In order to arrive at this collaboration, **awareness and understanding** was created. A **facilitating organization was able to drive the process** and **ensure trust** among the stakeholders. **Small-scale showcases** at national and bilateral levels proved to be successful; further uptake was achieved by **creating IAP working groups** for **pilots along European Corridors**. The **IAP framework** was developed and, after 2030, all stakeholders worked towards further deployment and implementation of IAP. As such, High Capacity Transport was incorporated in policy for sustainability, and contributed to a seamless, safe and sustainable transport system.

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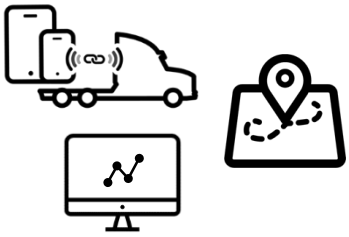
## Key achievements by each stakeholder group

- Trust among all **USERS** was gained
- Creation of a system that worked and was adaptable to everybody's interest and capabilities
- Data was made accessible for all without compromising security

- Establishment of a common harmonized framework at European level with local applications
- **POLICYMAKERS** acted as frontrunners

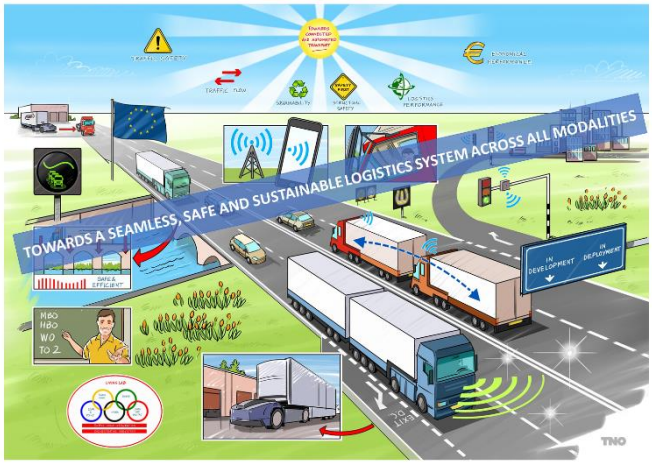


- The telematics **PROVIDERS** worked together to develop linkages between the various systems so that the right data could be disclosed. The FMS organizations ultimately found a business case in developing IAP platforms and services

- **PLANNERS & OWNERS**: Trust for data sharing was ensured by anonymizing data as much as possible
- Road authorities got a tool which enabled them to plan infrastructure maintenance more optimally

- Governance structure of **FACILITATOR** was established
- Mandate from the EU and DG Move was ensured

- Public perception changed and **SOCIETY** was able to see the advantages of IAP in their communities




## Colophon

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**Date**: September 2021