EMS2 CHALLENGE 360 DEGREES

L.A.C. AARTS
Ministry of Infrastructure and Water Management, Rijkswaterstaat
Senior Advisor Freight Transport.

S. VAN LIESHOUT
Project Manager Smart Mobility & Smart Logistics at Royal Haskoning DHV (RHDHV)

G. DE CARITAT
IVEX NV, Business Developer in ADAS/AD Software Solutions
MA, Louvain School of Management, Business Engineering

T. DEVOS
IVEX NV, Product Manager/Software Engineer in ADAS/AD Testing & Virtual Sensing Solutions
PhD, KU Leuven, Mechanical Engineering

T

Abstract

The Netherlands is considering allowing an EMS2 on a dedicated part of the road network. The EMS2 is a truck combination consisting of a towing vehicle, two semi-trailers and a dolly (max. 32m/72T). There are many lessons to be learned from other countries in Europe where vehicle combinations of this length are already in operation. However, the road network in The Netherlands is incomparably finely branched, complex and intensively used, which means that insufficient knowledge and experience is available abroad. The Ministry of Infrastructure and Water Management organizes the so-called EMS2 Challenge 360 Degrees, challenging the market to develop a monitoring system that integrates data from the vehicle, external data about the conditions and 360 degrees camera images and presents the most risky events based on built-in calculation rules. Parts of such a monitoring system are available on the market, but the challenge lies in the combination. This paper describes the development of the functional requirements for the monitoring system, the process of assessing the proposals submitted by consortia and the ultimately winning concept.

Keywords: High Capacity Transport, Traffic Safety, Intelligent Access

1. Introduction: the need for an EMS2 360 degrees monitoring system

The Ministry of Infrastructure and Water Management in The Netherlands is considering allowing an EMS2 on a dedicated part of the road network. EMS stands for European Modular System. It indicates a heavy duty vehicle combination that consists of standard European legally permitted vehicle units such as a tractor, trailer and a dolly. Each vehicle unit complies with the applicable maximum weights and dimensions described in the EC Directive 96/53 (https://transport.ec.europa.eu/transport-modes/road/weights-and-dimensions_en). The EMS1 refers to a heavy duty vehicle combination of maximum 60T/25.25m. The EMS2 is a heavy duty vehicle combination consisting of a tractor, two semi-trailers and a dolly (max. 32m/72T). The longest heavy duty vehicle combination currently permitted in The Netherlands is an EMS1.

Figure 1 – Road Map of Europe (https://mapofeurope.com/road-map-of-europe/ (2015)

In Europe, there are four countries where the EMS2 is permitted (regularly or on a trial basis): Finland, Sweden, Spain and Denmark. In order not to reinvent the wheel, an exploration was carried out into what could be learned for the Dutch situation from the knowledge and experiences in the four countries mentioned. In those countries, much research has been done, particularly in Finland (Riikka Rajamäki and Otto Lahti, 2023) and Sweden (Jesper Sandin, 2023), into road safety in relation to the EMS2. However, this research focuses on the secondary road network and the interaction between the EMS2 on the one hand and

vulnerable road users such as cyclists and pedestrians on the other. It is argued that motorways are designed to accommodate heavy duty vehicles and there is no oncoming traffic (Vejdirektoratet, 2021). They are considered sufficiently safe.

The map presented in Figure 1 clearly shows that the motorway network in the Netherlands is much more finely branched and therefore more complex than the motorway network in the other four countries. Although the map is already 10 years old, the situation will not have changed much when it comes to the density ratios of the road network. The Netherlands is relatively highly urbanized. On and off ramps are closer together and motorway junctions and merging mean that traffic has to change lanes more often. In addition, the motorway network in the Netherlands is used much more intensively. And the location of the largest port in Europe in Rotterdam means that a lot of freight transport takes place by road between the port and the hinterland. The port's service area extends far beyond the country's borders. For the secondary road network, residential and living areas are much closer to the motorway network and therefore the chance of interaction between an EMS2 and vulnerable road users is many times greater. It cannot therefore be automatically assumed that the EMS2 with its extra length simply fits within the traffic conditions in the Netherlands. The conclusion of the exploration of foreign learning experiences was therefore that this is where the greatest knowledge gap lies. If the EMS2 does not fit into the traffic conditions in the Netherlands anyway, all other questions are irrelevant.

It was then decided by the Ministry of Infrastructure and Water Management to conduct an EMS2 Pre-Test focusing on monitoring the interaction between the EMS2 and other road users on motorways and the route on the secondary road network from the motorway to an industrial area. The EMS2 Pre-Test is performed by 1 EMS2 vehicle and a regular tractor-trailer combination. The government is the initiator, no transport companies participate and no commercial cargo is transported. The intention is that this EMS2 Pre-Test will be performed in the summer of 2025.

The next question was how this interaction could best be monitored. Some examples of previous road safety studies on the EMS1 in The Netherlands used: observation by a co-driver (SWOV, 2008); surveys among car drivers (TNS Nipo Consult, 2005; I&O Research, 2009); and experiences of truck drivers and accident analyses (Arcadis, 2009; Arcadis and NEA, 2011; Arcadis, 2015). In order to be able to properly assess the safety risks, it is desirable to be able to monitor what is happening around the EMS2 and not be limited by the field of vision from the truck cabin. For example: a car wants to merge onto the motorway where an EMS2 is driving in the right lane. The car driver thinks he can merge in front of the truck, but notices during acceleration that the truck is much longer than he had estimated. The car driver drops back and wants to merge behind the EMS2, but there is now little space. While the EMS2 drives on calmly, all sorts of things can happen behind the truck combination, in which the length of the vehicle has played a role.

360 Degrees truck camera systems in use are focused on driver assistance and are still rarely used for monitoring purposes of traffic safety. Only in Sweden has traffic safety research been done with 360 degrees view cameras (Sandin, J., Renner, L., and Andersson, J., 2012; Jesper Sandin, 2023). However, in the former (older) study the Swedish design and use of the motorway network is too far removed from the Dutch design and use. In the latter study the focus is on interaction with cyclists. Another wish was that the images from the 360 degree camera would be linked to in-car data such as a hard braking action. That the monitoring system would then generate from the integrated data by incorporating certain thresholds, only

those events that require further investigation. The question was whether such a monitoring system was available on the market.

Reading guide
Therefore, the National Road Authority Rijkswaterstaat, part of the Ministry of Infrastructure and Water Management, organized the so-called EMS2 Challenge 360 Degrees in which the market is challenged to develop a monitoring system. Parts of such a monitoring system are available on the market, but the challenge lies in the combination. The following paragraphs explain in turn: paragraph 2 the mapping of the functional requirements for the 360 degree monitoring system; paragraph 3 the results of a market survey; paragraph 4 the publication and the set-up of the Challenge; paragraph 5 the Final Event; paragraph 6 the winning concept; and paragraph 7 the follow-up to the EMS2 360 degree Challenge.

2. Functional-technical requirements for the EMS2 360 degrees monitoring system

The Global Consulting Engineering Company Royal Haskoning DHV (RHDHV) has been asked to facilitate the EMS2 360 Degrees Challenge. The EMS2 360 Degrees Challenge consisted of a literature study and expert workshop to arrive at functional requirements for the monitoring system; a market survey; the publication of the call for tenders; assessment and selection of submitted proposals to be selected at a final event; the organization of the final event and leading the jury assessment of the selected proposals; and the drafting of the jury report.

What should the monitoring system be able to observe, under what circumstances?
The first step to arrive at the functional-technical requirements of the monitoring system was based on literature study and expert judgment. The literature mainly concerned a large-scale study in 2007 into the impact of increasing road freight transport on, among other things, road safety (Oranjewoud and KOAC.NPC commissioned by Rijkswaterstaat, 2007); the series of accident analyses carried out between 2009 and 2015 with regard to the EMS1 (in Dutch LZV = Longer and Heavier Vehicle); and the final report of the Pilot Intelligent Access for Special Road Transport from 2023 (Rijkswaterstaat, 2023). A test report from the RDW of an unsuccessful previous attempt to obtain an exemption for an EMS2 also served as a source (RDW, 2021). It was examined which safety risks can be controlled by requirements for the vehicle, the qualification of the driver or adjustments to the infrastructure. And which safety risks cannot be controlled in advance and should be monitored in order to assess whether there are indications that road safety will deteriorate due to the introduction of the EMS2 in Dutch traffic. The result of this is shown in Figure 2 below.

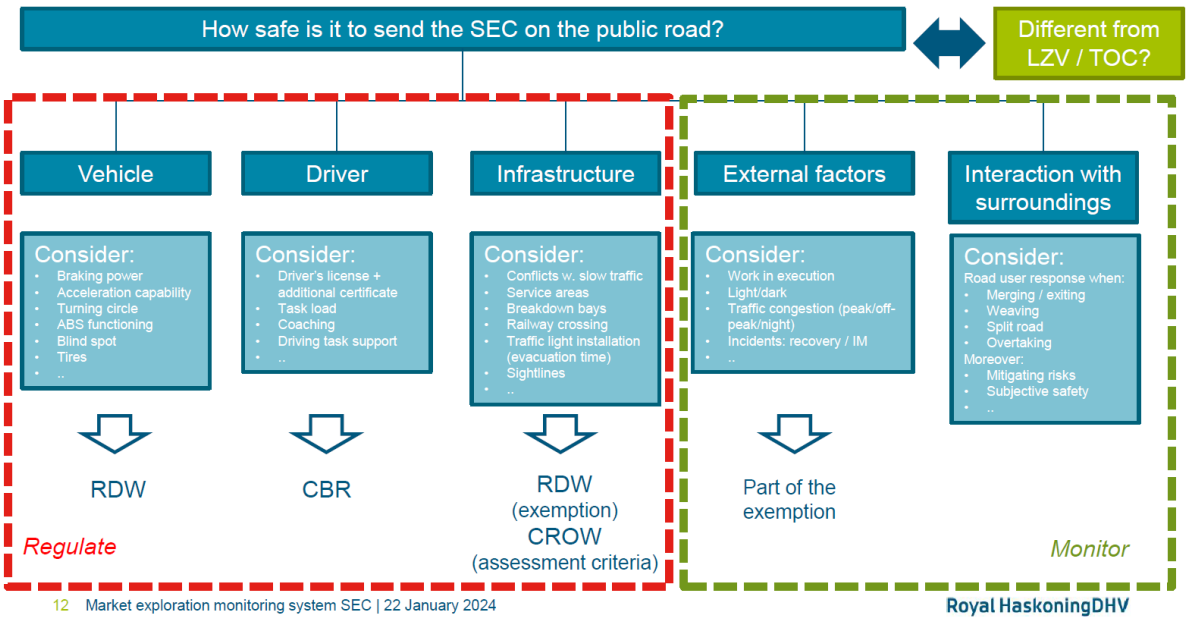

Figure 2 – Overview of variables for the workshop to arrive at functional requirements for the EMS2 360 Degrees monitoring system

Many different variables can play a role in traffic safety of a EMS2-vehicle on a public road. The variables can be divided into the following categories:

- *Vehicle*: acceleration rate, deceleration rate, turning radius, tires, available advanced driver assistance systems, etc.
- *Driver*: driver's license, additional certificate for EMS-vehicle, coaching, task load, driving task support, driver's competence.
- *Infrastructure*: conflicts with vulnerable road users (pedestrians, bicycles), service areas, sightlines, traffic lights (evacuation time of the junction).
- *External factors*: weather conditions, congestion (peak hours, off-peak, night), incidents, road works, light/dark.
- *Interaction with surroundings*: road user response on interchange points (weaving lanes, entrance and exit ramps, motorway junctions) and lane changes. But also subjective road safety.

Variables relating to the vehicle, the driver and the infrastructure can be regulated in the exemption by imposing requirements. The RDW usually coordinates the process of granting the exemption. It has set up a process for this purpose in which all stakeholders are involved in determining the conditions under which an EMS2 may participate in traffic on public roads. The RDW draws up technical vehicle requirements together with the stakeholders and tests these in a test against the performance of the EMS2 vehicle offered. Together with the Central Driving License Office (CBR), the RDW determines which type of driving license and any additional certificates are required to be allowed to drive an EMS2. The road authorities involved assess the roads where the EMS2 may drive and under which conditions.

External factors such as weather conditions and traffic density can play a role in safety risks when the EMS2 interacts with other road users. Authorities can include restrictions in the exemption to prevent risks. For example, the road authority can state that the EMS2 is not allowed on the public road during rush hour or, conversely, not when it is dark. However, for

a proper assessment of the safety risks of participation in traffic of the EMS2, it is important to monitor the EMS2 under as many normal circumstances as possible. The exploration of the foreign learning experiences does not give reason to impose restrictions in advance on access to the motorway network under any circumstances whatsoever, with the exception of extreme weather conditions. However, Sweden, Denmark and Spain explicitly limit the use of the secondary road network in order to avoid interaction with vulnerable road users as much as possible.

Participating in traffic is risky in general. The interaction between regular heavy duty vehicles and other road users can lead to potentially risky situations that are typical for this interaction. For example, the maximum speed for passenger cars is higher than for heavy duty vehicles, whereby the mutual speed differences can potentially lead to conflicts. It is therefore important that the typical risks of the interaction between passenger cars and heavy duty vehicles in general are filtered out. The desired innovative monitoring system provides much more insight than is usually the case in road safety studies. There is a chance that a whole range of potential risks are observed that are not necessarily caused by the extra length of the EMS2. Therefore, in the PreTest, the EMS2 will be compared with a regular tractor-trailer combination (TOC in Dutch) and an EMS1 (LZV in Dutch).

Data about the driver's competence and task load (human factors) were out of scope. The driver's behavior in connection with the use and setting of driver assistance systems in the vehicle did fall within the scope of the research.

What should come out of the monitoring system so that analyses can be made of the most critical traffic situations?
The monitoring system must provide Rijkswaterstaat with information about the behavior of the EMS2 itself, as well as the behavior of other road users in response to the EMS2. Based on analysis of the most critical situations, it can be assessed whether a pilot with an EMS2 in which companies participate can take place safely and responsibly. The analysis can also provide starting points for the conditions that can be set for granting the exemption in order to control road safety risks.

When describing the output of the monitoring system, the following research questions are involved:

- Which events can be identified during the interaction between the EMS2 and other road users that pose a clear risk to road safety (both in absolute and relative terms compared to an EMS1 and a regular tractor-trailer combination)?
- How can data that provide context for the analysis of vehicle characteristics, road characteristics, traffic situations, environmental conditions (particularly intensities, weather and light), measurements of vehicle performance and data from the camera systems be integrated?
- How can the events be made available in a manageable quantity so that they are suitable for further analysis?

These research questions also provide direction for the functional requirements of the monitoring system.

The system must be able to distill events from data and translate them into information, in conjunction with data from other already available systems and services in and about vehicles (including CAN bus, EDR, DSSAD, FMS/GNSS) and available public statistics for road safety.

The events must be visualized in an accessible dashboard. The dashboard must not only provide an overview, but can also be used for further analysis of the most unsafe locations and situations. It must be possible to analyze the events objectively, based on calculation rules. For example, it must be possible to use filters to analyze in the dashboard whether external factors such as weather conditions have had an effect on the number of unsafe events. Furthermore, it must be possible to analyze whether the events are caused by interaction with other road users and to gain more insight into the cause of the event. For example: was the other road user in a dead end, did the driver misjudge the length of the EMS2 or did the event have nothing to do with the length of the vehicle? These latter analyses are subjective, based on viewing and assessing camera images. The monitoring system does not need to do this analysis of the events. For that, experts in the field of traffic safety are called in from a separately hired consultancy firm.

The technical requirements of the monitoring system are mainly about bringing together all the necessary data. In order to extract events, the system must use both publicly available data and private data from the available vehicle systems. Data that is not available as publicly available data or vehicle data (CAN bus, EDR, DSSAD, FMS/GNSS) must be provided by adding sensors (cameras or others). The usability and quality of these sensors, as well as integrating and processing all this data and extracting meaningful events for further analyses, are the main challenges for the monitoring system.

The literature study and the workshop resulted in a document listing the concept functional requirements for the monitoring system. These concept functional requirements formed the starting point for the market exploration.

3. Market Survey: Looking for the available expertise in the market

The first step prior to the market approach was to investigate whether a monitoring system that meets the functional requirements as determined is available on the market. And if the answer would be no, which parties do have the expertise to develop such a monitoring system. In this step, the intention was not to make an inventory of the products available in this area on the market. The approach was to ask dominant suppliers of hardware and software whether such complex traffic monitoring systems or related systems are available on the market. And if such systems are not available, whether they could indicate to what extent the functional requirements of the desired monitoring system are feasible? To this end, a long list of potential candidates to approach was drawn up based on existing knowledge of the market and an orientation via Google. The parties varied from operating as OEMS (such as Valeo, Mercedes Benz and Orlaco) to operating in the after-market (such as Mobileye, Rietveld and Camos), from hardware (such as Skeyewatch, Samsara and Hella) to software providers (such as VDO, Prometheus and Trimble).

To gain more insight, two information meetings were held to explore the market. A selection of parties was approached and those who were interested were invited. During the meetings, an explanation was given of the reason why Rijkswaterstaat is looking for a monitoring system in relation to the EMS2. Subsequently, it was explained how the functional requirements of the monitoring system had been established. The following questions were put to the market parties present:

- Are there parties in the market that can realize the requested monitoring system?

- Is it technically feasible? Does that apply to all requirements? Does that also apply to all steps of data processing (collecting, analyzing and storing)?
- Is it possible to achieve the desired integration of data from different data sources?
- Do market parties have any other points of attention or additions on a technical level?
- What are the expected costs of developing such a monitoring system?
- How much time is needed to develop such a monitoring system?
- How do the present market parties view the business case?

The two information meetings showed that there was interest in the market to participate in a Challenge. It also showed that the market is highly specialized in submarkets of data science, sensoring and dashboarding. Therefore, it would most likely require a consortium of parties to achieve the desired goals. The difficulty in this was that these submarkets do not know each other well enough. They operate in completely different markets. The market survey provided sufficient confidence to launch the EMS2 360 Degrees Challenge.

The market exploration also provided valuable insights for the functional requirements of the monitoring system. This resulted in a final list of functional requirements that was sent with the official call for the Challenge to the market. The functional requirements for the monitoring system are summarized in the criteria on which the proposals are assessed. This is explained in the paragraph below.

4. Launching the Call for the EMS2 Challenge 360 Degrees

The Call to submit a proposal for the EMS2 Challenge 360 degrees was made on April 25, 2024 by the Chief Engineer-Director Marlouke Durville of Rijkswaterstaat. Companies were given until May 22, 2024 to express their interest and until June 19, 2024 to develop a proposal on paper. The functional specifications were given in the invitation letter and an attachment.

Entries for the EMS2 Challenge 360 Degrees are judged on the extent to which the monitoring system complies with:

1. Answering the research questions.
2. Organization: extent to which the company or consortium can demonstrate relevant experience, reliability and creditworthiness.
3. Functional feasibility:
    a. Being able to distill events from data and translate them into information, in conjunction with data from other already available systems and services in and about vehicles (including CAN bus, EDR, DSSAD, FMS/GNSS) and available public statistics for road safety.
    b. Visualization via an accessible dashboard for an overview and further analysis of the most unsafe locations and situations.
    c. The following analyzes must be possible:
        – Objectively based on calculation rules
        – Subjectively based on reviewing and assessing camera images
4. Technical feasibility:
    a. Availability of all required data items
    b. Usability and quality of sensors and data

   c. The party (or combination of parties) must be able to implement a working monitoring system within 3 months in order to be able to use it for a pretest in the autumn.
   d. The party (or combination of parties) must be able to deliver the monitoring system in its entirety. This means: monitoring the environment of the vehicle, collecting and integrating necessary indicators for logging events, processing data into information, dashboard/analysis tool.
5. Identifying risks and opportunities for feasibility:
   a. Consider legal (DPIA) or financial (incidental and structural costs and benefits for whom).
6. Scalability:
   a. To other vehicle configurations and OEMs
   b. To multiple vehicles
   c. To access roads to industrial estates and roads on industrial estates.
7. No weighting/difference in weight has been assigned to the criteria, all criteria have equal weight.

The composition of the jury was chosen in such a way that the proposals would be examined in different ways: for example, from the perspective of road safety, the EMS2 project and privacy legislation. An attempt was made to achieve a balanced composition of the jury in which all necessary expertise was present.
The jury of the EMS2 Challenge 360 Degrees consisted of:

1. Suzanne van Lieshout, Chair of the Jury (Project Manager Smart Mobility & Smart Logistics RHDHV)
2. Arjan van Vliet (Project Manager SEC, Ministry of Infrastructure and Water Management, Policy Department)
3. Marcel Otto (Strategic Advisor Freight Transport and Smart Mobility expert Ministry of Infrastructure and Water Management, Rijkswaterstaat)
4. Ogie Elugamhe Senior Advisor with legal expertise Ministry of Infrastructure and Water Management, Rijkswaterstaat)
5. Reinier Jansen (Road safety and specialist Naturalistic Driving methods, Institute for Road Safety Research)
6. Bram Hendrix (Program Manager Smart Mobility & Internationalization, RAI Association)

An amount of €15,000 was made available for the winner of the Challenge. In addition, the winner will be the preferred candidate for supplying the monitoring system for the EMS2 PreTest.

5. Final Event EMS2 Challenge 360 Degrees

The outcome of the Challenge exceeded expectations, both in terms of the number of proposals submitted and their quality. Rijkswaterstaat received six proposals. After an initial selection, the following four consortia were invited to present their concept in detail to a jury during the Final Event on 3 July:

1. IVEX / Rudozi: IVEX is a relatively new player in the market from Leuven, Belgium, in the field of autonomous vehicles in relation to road safety. Rudozi is a Dutch company that will supply the hardware.
2. Camos / SkyAutoNet Inc.: Camos is a large, globally operating player specialized in digitalization (Software, consulting and support). The proposal was submitted by the

German branch of the originally Korean group. SkyAutoNet Inc. is a global company from Seoul in the field of smart mobility.

3. Red Sentinel / AEVA / Komboi / TNO / ESTECO: Red Sentinel is a company that specializes in bringing together the knowledge and skills of different companies in order to meet a specific demand. The focus is on smart mobility issues.
4. V-Tron / MapTM: Dutch consortium of V-Tron and MaptTM, both of which were previously involved in the RWS Pilot Intelligent Access for special road transport (2021-2023). V-Tron is specialized in hardware and MapTM more on the software.

The presentation that would be most convincing based on the assessment criteria mentioned in paragraph 4 would be declared the winner by the jury.

General observations in the EMS2 Challenge 360 Degrees Jury Report (RWS, 2024)
The jury assessed the proposals with great interest and pleasure and appreciated the time and effort that the participants had put into their proposals. All entries were of high quality and showed sufficient knowledge and experience in monitoring road safety issues with heavy duty vehicles.

The jury noted that monitoring 'events' based on interactions with other road users is a new item, which was also reflected in the proposals. Most monitoring systems focused on the ego vehicle (EMS2), but in this case also events from other vehicles are interesting. Although the ego vehicle contains the sensors, the reaction or trigger does not necessarily have to be with the ego vehicle (not braking, not changing lanes etc.). The focus of the proposals was not yet on thinking from the perspective of other road users. The jury is curious whether there are more possibilities to monitor/visualize this.

It was also noticeable that specific knowledge of the EMS2 vehicle characteristics, the intended operational design domain (ODD) and the impact on possible road safety risks were not or hardly reflected in the proposals. While this can have an influence on the practical implementation. Think of communication between trailers, interchangeability during trailer/truck changes, etc. Challenges will arise here in the rest of the process.

Figure 3 – EMS2 Challenge 360 Degrees Final Event (3 July 2024) Presentation of the Camos / SkyAutoNet Inc consortium

After all participants presented their proposals during the Final Event on July 3, the jury retired for deliberation. They unanimously decided to declare the IVEX/Rudozi consortium the winner of the EMS2 Challenge 360 Degrees.

The profit of the challenge was not only for the winner, but did also benefit the other parties. Because in normal outsourcing the parties do not see each other's proposals, all participants in the Challenge appreciated the fact that they could now learn about other perspectives and other expertise and competencies of parties operating in a different market.

6. The winning concept: IVEX/Rudozi

The winning concept for the EMS2 monitoring system is an advanced, integrated platform that merges data from the vehicle, surrounding conditions, and external sources to enhance road safety and traffic flow. This system, developed by IVEX in collaboration with Rudozi, employs state-of-the-art sensors, cameras, and data analytics software to monitor and assess the impact of the EMS2 on Dutch roads.

Figure 4 – EMS2 Challenge 360 Degrees Final Event (3 July 2024) Presentation of the IVEX / Rudozi consortium

System architecture and components:

1. **Vehicle and sensor data integration**: The system gathers telemetry from the EMS2 vehicle (e.g., CANbus data, speed, braking, GPS location) and combines it with external data from LiDAR, cameras, and environmental sources. This provides a 360-degree view around the vehicle, capturing all relevant interactions with other road users.
2. **Event detection and analysis**: The software platform identifies critical driving events, such as hard braking and lane changes. These events are contextualized using the integrated data, highlighting high-risk scenarios and driver behaviors for further analysis. The system supports scenario categorization (e.g., cut-ins, overtaking) and parameters like time-to-collision (TTC), safe following distance, and speed differentials.
3. **Data presentation and visualization**: A user-friendly dashboard presents aggregated event data and visualizations, enabling easy access to insights. Events are mapped, showing their geographic location and severity. Filters allow users to dive deeper into specific scenarios and explore further through replay functionalities. Camera footage from before and after key events is available for additional context.

Key considerations:

1. **Scalability**: The system is designed to handle large volumes of data and can be adapted for future expansion across different vehicle types and configurations

2. **Data privacy and security**: The system complies with GDPR requirements, with personal data anonymized (e.g., face and license plate blurring) to ensure privacy
3. **Technical flexibility**: The data analytics dashboard is highly customizable, supporting various sensor types and offering flexible integration with external data sources such as weather and traffic databases

The system's combination of multi-source data collection, robust analytics, and intuitive visualization ensures comprehensive monitoring of EMS2 vehicles on Dutch roads, improving safety and operational efficiency.

7. References

- Arcadis (2009) Monitoring traffic safety Longer and Heavier Vehicles
- Arcadis and NEA (2011) Monitoring Traffic Safety Longer and heavier vehicles
- Arcadis (2015) LHV accident analysis 2011-2013 Including an overview of conclusions based on LHV accidents between 2007 and 2013
- https://mapofeurope.com/road-map-of-europe/ (2015) Road Map of Europe
- https://transport.ec.europa.eu/transport-modes/road/weights-and-dimensions_en
- I&O Research (2009) Survey car drivers Longer and Heavier Vehicles
- Jesper Sandin (2023) "Accident involvement of truck combinations up to 25.25m and studies of longer HCT and cyclist safety" in the Proceedings of the Nordic HCT Conference
- Oranjewoud and KOAC.NPC commissioned by Rijkswaterstaat (2007) Vrachtverkeer en Weginfra. Eindrapportage Invloed groeiend vrachtverkeer
- RDW (2021) Testrapport Super Eco Combi
- Riikka Rajamäki and Otto Lahti (2023) "Impact of increasing truck length and weight - Finnish experiences" in Proceedings of the Nordic HCT Conference
- Rijkswaterstaat (2023) Pilot Intelligente Toegang Bijzonder Wegtransport. Onderzoek naar haalbaarheid en schaalbaarheid.
- Rijkswaterstaat (2024) EMS Challenge 360 Degrees Jury Report
- Sandin, J., Renner, L., and Andersson, J. (2012), "The effect on passenger cars' meeting margins when overtaking 30 meter trucks on real roads", In Proceedings of the Applied Human Factors and Ergonomics Conference (AHFE), July 2012, San Francisco, California, USA.
- SWOV (2008) Verslag observaties LZV's
- TNS Nipo Consult (2005) Reacties op Lange Zware Vrachtwagens (LZV's) in het verkeer
- Vejdirektoratet (2021) Analyse af forsøgsordning med dobbelttrailere (DUO2)