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**CARTRE**  
Coordination of Automated Road  
Transport Deployment for Europe

**Micro-FESTA – lessons learnt from small pilots**

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## **1. Introduction**

### **1.1. CARTRE project**

CARTRE, Coordination of Automated Road Transport Deployment for Europe, is a Support Action submitted for the call H2020-ART-2016-SingleStage-RTD. CARTRE aims to accelerate development and deployment of automated road transport by increasing market and policy certainties. To achieve this, CARTRE will support the development of clearer and more consistent policies for EU Member States in collaboration with industry players, ensuring that automated road transport systems and services are compatible at EU level and are deployed in a coherent way.

The Grant Agreement number is 724086 and project duration is 24 months, effective from 01 October 2016 until 30 September 2018. It is a contract with the European Commission (EC), DG Research and innovation (RTD).

The EC Project Officer is: Mr Ludger Rogge EUROPEAN COMMISSION DG RTD – H.2 Surface Transport Office: CDMA 04/127 B - 1049 Brussels

### **1.2. Goal of this document**

The goal of this document is to demonstrate the need for Micro-FESTA, a methodology to extract lessons learnt from relatively small pilots for which the full FESTA methodology seems to be too much work.

### **1.3. Executive summary**

CARTRE is a Coordination and Support Action to accelerate development and deployment of automated road transport by increasing market and policy certainties.

At a national level, a variety of small pilots with connected and automated vehicles are carried out. These are not of such magnitude that a full FESTA approach for Field Operational Tests seems justified in terms of capacity and budget. However, not writing down any lessons learnt is on the other side of the spectrum and is not in line with the spirit of learning by doing that goes hand in hand with doing pilots. Therefore, guidelines for adapting the FESTA methodology would support small-scale testing. The goal of this document is to demonstrate the need for micro-FESTA, a methodology to extract lessons learnt from relatively small pilots for which the full FESTA methodology seems to be too much work. It suggests how the FESTA steps can be used in small projects.

A dedicated workshop was organised by CARTRE in February 2018 to explore opportunities and possibilities to document lessons learned from small-scale CAD pilots without using the full FESTA methodology.

A use case study has been made for self-driving shuttle buses or PODs in the Netherlands, providing guidelines for granting exemptions. In the Netherlands many of PODs demonstrations and trials are carried out, initiated by municipalities, cities and regions. The Dutch exemption process and risk assessment are described in detail.

This document describes:

- a) The need for Micro-FESTA
- b) The relevant steps for a short version of FESTA
- c) Stakeholder workshop (27-02-2018) on Micro-FESTA
- d) Generic use case PODs in The Netherlands

## 2. The need for Micro-FESTA

Not every pilot carried out with connected and automated vehicles is of such magnitude that a full FESTA approach seems justified in terms of capacity and budget. However, not writing down any lessons learnt is on the other side of the spectrum and is not in line with the spirit of learning by doing that goes hand in hand with doing pilots. Therefore, guidelines for adapting the FESTA methodology would support small-scale testing.

Small national projects may deal with practical deployment issues that may not come up in EU-level research programmes. Small projects can contribute to the knowledge gathering on the effects of road automation. There are several questions these projects can help to address. First there is the question of why we want to know, in other words, the policy question. Knowledge about impact is needed for a variety of stakeholders in order to be able to make decisions. Industry has to develop business plans and determine how these new technologies and services can best be deployed. Political decisions need to be taken: where do we invest, what do we subsidize, what do we allow, and what should be prohibited.

The next question is: when are we convinced about the likelihood of positive and negative aspects of automation? In other words: the evidence question. There are several answers to this. We could look at the user and societal acceptance. Is automation answering user needs and preferences, is the general public willing to adopt these new ways of transport and change their mobility? Another way of answering the question is by looking at the business side. Do industry business models predict profit, and are governments subsidizing technological development and implementation?

We could also ask for scientific evidence: can we find proof that the promises about, for example, improved safety and mobility can be realised? This brings us to the next question: how do we investigate the effects, in other words: the methodology question.

### 2.1. The FESTA methodology

#### FESTA

In order to set-up and conduct Field Operational Tests (FOTs), and to analyse the results and perform impact assessment, the FESTA methodology was developed, see Figure 1. In the European Commission funded FESTA project a common FOT methodology was developed, which is now widely used as the basis for the planning and execution of FOTs. Since the original FESTA project, the methodology has been maintained and updated by FOT-Net support actions (FOT-Net, FOT-Net 2 and FOT-Net Data) from 2008–2016. At the end of 2016, version 6 of the revised handbook was released. The scientific evidence based approach forms the key principle of the FESTA methodology. It provides and advocates a systematic research-oriented approach to define and conduct FOTs, and analyse the results in order to assess the potential impacts.

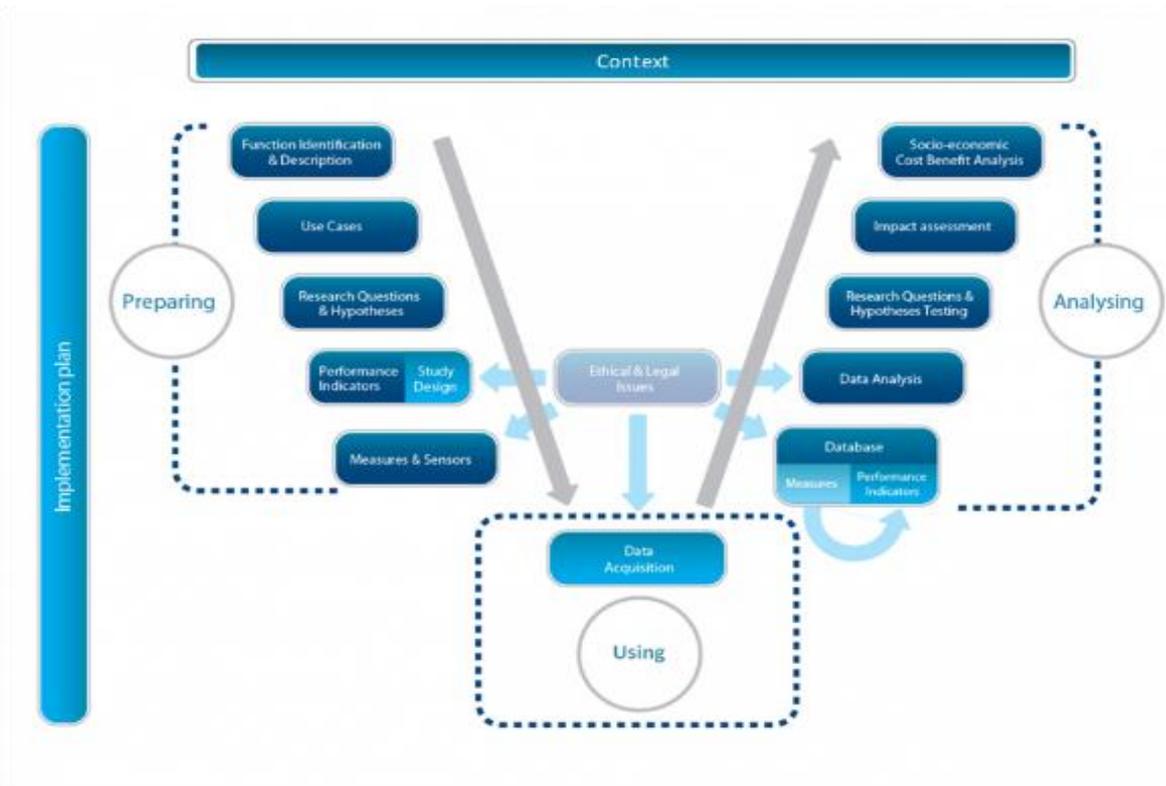


Figure 1: The FESTA Methodology

### The need for a common methodology

A common methodology adopted by projects has major advantages, allowing for comparison of results between FOTs, and providing a common vocabulary, enhancing communication between a wide variety of people involved in FOTs. The methodology is not a rigid one, it is adaptable and kept alive by workshops in which experiences are exchanged.

For automation studies a common methodology is even more important, as we are not only interested in the findings of individual projects, but in gaining knowledge about the wider impacts automation may have.

The FESTA methodology puts a strong emphasis on defining research questions and hypotheses, inspired by the traditional impact areas of safety, mobility, environment and efficiency. With the new developments, not only in technology but also in transport services, impact areas will be wider and sometimes new (e.g. land use), thereby multiplying the number of research questions that are of interest.

### 2.2. Micro-FESTA

The FESTA handbook in which the methodology is described in detail (<http://fot-net.eu/wp-content/uploads/sites/7/2017/01/FESTA-Handbook-Version-6.pdf>) consists of some 200

pages. As the methodology was developed for large-scale FOTs, this is probably far too much detail for beginners to start from in small projects. However, there is a lot of practical information in the handbook that is useful, when reaching certain steps in a project.

The Micro-FESTA approach can be described in three phases of the FESTA-V:

Preparing:

- Defining the study: Defining functions, use cases, research questions and hypotheses
- Preparing the study: Determining performance indicators, study design, measures and sensors, and recruiting participants

Using:

- Conducting the study: Collecting data

Analysing:

- Analysing the data: Storing and processing the data, analysing the data, answering research questions
- Determining the impact: Impact assessment and deployment scenarios, socio-economic cost–benefits analysis

### Defining the study: Defining functions, use cases, research questions

In this step the study is defined. The main questions to address are what will be evaluated and how will that be done?

The following sub-steps can be distinguished:

- a. Selecting the **functions** to be tested: define whether some automated functions are tested or the functioning of whole vehicle and/or automated service
- b. Defining the connected **use cases** to test these functions: define in which conditions the vehicle is driving automated.
- c. Identifying the **research questions**: what are the questions the study should answer. Defining research questions is usually a difficult and iterative process, as many questions around automation can be posed, but not all questions can be addressed. Stakeholder involvement is crucial in prioritization, what kind of questions do they think are important? Research questions are closely related to the impact area the study is interested in, such as safety, mobility, traffic efficiency, business models or technical functioning? Small projects should have a clear focus to ensure results.

### Preparing the study: Determining performance indicators, study design, measures and sensors, and recruiting participants

In this step the study is prepared. The main question is how can the study be set-up in order to be able to answer the research questions?

The following sub-steps can be distinguished:

- a. Defining **performance indicators and measures**: define what indicators are to be used for answering the research questions and how they can be measured. For example, a performance indicator could be a high degree of user acceptance as measured with a technology acceptance questionnaire. Examples of performance indicators are widely available in impact assessment publications and FESTA.
- b. Defining the **study design**, or in other words, the **procedures** to be followed: determine the practicalities of the study, where will the study take place, for how long, who is to be involved. Ethical and legal aspects need to be taken into consideration.
- c. Defining **tools and sensors**: what kind of tools and sensors need to be used for measurements? These could for example be sensors in the vehicle collecting data about the vehicle performance, video to study the interaction with other road users, or qualitative instrument such as user questionnaires. For small studies it is important to determine what data can be collected within the limited resources available, preferably using existing products.
- d. Defining and recruiting the **participants**: who are the users who are going to be involved in the study and how are they recruited or to what members of the public will the service be offered? A consent form must be prepared for the participants in order to agree on use of personal data and on safety precautions. It is recommended to use existing templates, but legal advice may still be required.

### Conducting the study: Collecting data

When the study design is completed, data can be collected according to the plan.

The following sub-steps can be distinguished:

- a. **Pilot the procedures**: even with the most carefully defined study, in practice things may be different. Trying out the study in real-life conditions is essential to find out what works and where improvements need to be made. Proper piloting ensures that everything is ready for performing the study. During piloting, example calculations should be made to ensure that the collected data can yield results.
- b. **Perform the study and collect data**: keep a log on what happens during the study and the problems encountered. Examples are extreme weather or traffic conditions, or break-downs of the systems.
- c.

### Analysing the data: Storing and processing the data, analysing the data, answering research questions

The data collected need to be analysed in order to be able to answer the research questions.

The following sub-steps can be distinguished:

- a. **Storing** the data: data needs to be stored in a safe and secure way, taking into account data protection and privacy regulations
- b. **Documenting** the data: it is important that the data is documented for use later on and by other persons than the ones who collected the data
- c. **Analysing** the data: depending on the type of data and the questions to be answered the data needs to be analysed using statistical and/or descriptive methods. This may be work for a specialist.
- d. **Answering the research questions and presenting the results:** the data analysis will provide answers to the research questions posed, and need to be presented in a way that is comprehensible for non-experts, specifically the stakeholders.

### Determining the impact: Impact assessment and deployment scenarios, socio-economic cost benefits analysis

The last phase may be the most difficult one, trying to determine the wider impact of the study and determining how the results can be used for developing business models. It builds on clear data analysis results.

The following steps can be distinguished:

- a. **Scaling up** the results: determine what the results mean for a wider use of the automated vehicle or service in other areas. This step may be more or less complicated, having to use statistical or modelling techniques (e.g. traffic models)
- b. **Cost–benefits** analysis: determine what the costs are of deploying the vehicle or service and what the benefits are. These could be measured in monetary terms but also in qualitative terms.
- c. Performing **stakeholder analysis**: define who will potentially profit from the deployment of the system and what the benefits are for this group. Stakeholders may come from public authorities, industry (manufacturers and service providers) and end users. It may be useful to organise workshops with stakeholders, presenting and discussing the results and potential impacts and benefits.
- d. Developing **business and deployment models**: together with stakeholders it needs to be determined how the system or service will can deployed in the future, who will have to invest to realise wider use or bringing the system or service to market.

### Making the data and results available for others

In order to be able to contribute to a bigger picture about the impact of road automation the following recommendations should be taken into consideration:

- **Sharing data**: make data available for further research, ensuring that this data is anonymized and non-confidential.
- **Document** the study design, the data collection process, the data and the results in such a way that others can understand what was done and are able to re-use this information.
- **Publicise** the results and main documents for a wider audience.

A final element of FESTA is to be mentioned:

The **FOTIP**: the FOT Implementation plan to be found in the handbook, which may serve as a practical checklist. It highlights the main activities and tasks that would normally be undertaken in successfully completing the project and raises awareness of critical issues.

### 3. Workshop Micro-FESTA

#### 3.1. Workshop Utrecht 27-2-2018, program

On February 21st 2018 CARTRE organized a dedicated workshop to explore opportunities and possibilities to document lessons learned from small-scale CAD pilots without using the full FESTA methodology. The venue was the Rijkswaterstaat office in Utrecht, The Netherlands.

The program

13.00-13.15 welcome and introduction by Tom Alkim and Yvonne Barnard (CARTRE)

13.15-14.15 presentations CAD pilots (NL/UK/BE/SE)

- NL – selection of Dutch pilot activities:
  - RADD – Arjan van Binsbergen (TU Delft)
  - Rivium 2 – Dennis Mica (2getthere) / Marc van der Knaap (OC Mobility)
  - ADaaS – Remco Derksen (Rebel group)
  - IAT – Joop Veenis (Future Mobility network)
- UK – Strategic Approach CAV Trials – Gareth Sumner (TFL)
- BE – VIAS institute pilot – Julie Maes (VIAS institute)
- SE – Gothenburg pilot – Victor Malmsten Lundgren (RISE)

14.15-14.45 presentation FESTA methodology and best practices for small scale pilots – Sami Koskinen (VTT) / Yvonne Barnard

14.45-15.00 coffee break

15.00-16.45 dedicated dialogue to explore opportunities and possibilities to document lessons learned - moderated by Yvonne Barnard / Tom Alkim

16.45-17.00 conclusions and wrap-up - Yvonne Barnard



figure 1, workshop presentation at Rijkswaterstaat office in Utrecht, The Netherlands

## 3.2. Results workshop

This workshop was held with a relative small but dedicated group of 11 experts from 5 EU member states. After setting the scene with presentations about various national small scale pilots with people movers and shuttles (see figure 2), a dialogue took place to explore the spectrum between a full FESTA approach and no methodology at all. The overall consensus of the group was that it seems a bit over the top to apply the full FESTA methodology to a small scale pilot (e.g. less than 3 vehicles, shorter than 4 months, etc.), however it makes sense to at least write down the lessons learned because this provides valuable information and experience on how (not) to set up pilots, scale up to FOTs or even deploy shuttles in an operational setting.

As with every workshop on automation the benefits and potential were being discussed and the group concluded that it's important to note that automation is not a goal in itself but a possible (part of the) solution to address an array of mobility challenges. In addition, government's positions in general seem to be that automated driving will come anyway and thus they have a choice. To embrace it and facilitate and/or speed up the deployment or to wait and see. Additional reasons for many public authorities to initiate automation projects are to attract economic activity to a specific region. Given the fact that automation is an instrument, it's important to define what the actual purpose of a project is. Is it to do a trial, to get experience and demonstrate or to (commercially) deploy a mobility solution? Part of the reason this workshop was dedicated to shuttles and people movers is that the demand for first and last mile solutions seems to be rising.

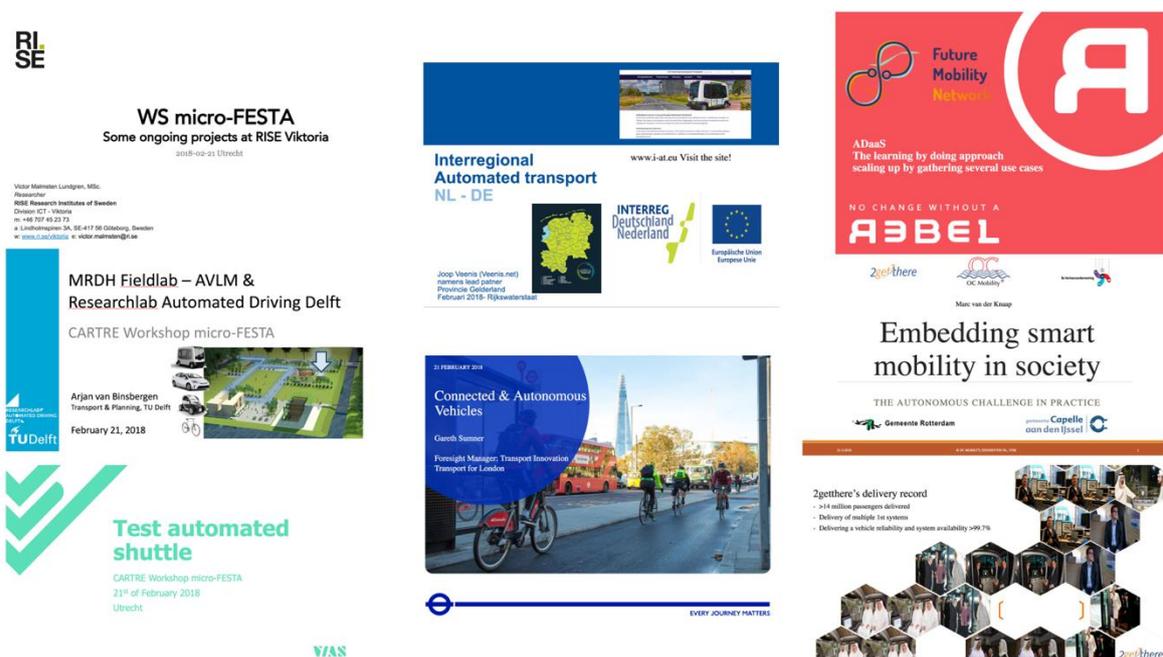


figure 2, the presentations

How to enhance learning from smaller pilots and FOTs? Some recommendations made by the group:

- Focus on practicality (max 20 questions)
- Define research questions, make them explicit
- Better systemized information on pilots (functionalities for instance)
- Set the right requirements (learn how to do this)

## What can be learned from other projects?

- Methods
- Communication about the project
- With relative little additional effort, a bit more can be measured
- Different pilots, different goals: e.g. solve mobility problems or develop automation

## Key elements to consider when preparing for a small(ler) scale pilot or FOT.

- With different stages of (technical) maturity come different levels of service.
- Balance between technology development versus societal benefits
- Balance between safety and efficiency (shuttles need to drive faster than humans walk...)
- Research goal(s) define(s) the set-up of the experiment
- How to collect empirical evidence?
- How to set up pilots and FOTs for a maximum learning effect?
- To what extent can you leave it up to the developers to test and prove the technology?
- Proving technology maturity and practical readiness
- How to scale up effects?
- Can results be transferred into models?
- Multi stakeholder representation is needed
- The smaller the project, the more stakeholders seem to be involved
- When working with private partners, some results and methods can be shared, but not all.
- Open data does not necessarily mean free data

## The presentations can be found in Annex 5.4

**Autonomous Base Camp (ABC)**

- approx. 20 potential shuttle initiatives around Sweden
  - public and private actors
  - create portfolio of use-cases
    - people
    - logistics
  - sync evaluation methods

**Lessons Learned 2017/2018**

For a single Use Case

- Know area, fixed route 0.5-10 km, 10-20 km/h
- Several parties must work together.
- Put use case owner in the lead not the local government.
- Stages: (pre-)feasibility, joint commitment, implementation, exploitation.
- Agreements for a longer time period, and be flexible, open and innovative.

**Lessons Learned**

- **LEGAL:** DE and NL approval processes for CAV are not the same. Vehicle versus situation safety perspective. RDW and TÜV do not have the same position in the process. Findings/approval documents or brand specific info is not shared.
- **TECHNICAL:** It is an emerging market. Integrating CAV Architecture in PT-Info and management systems is needed.
- **IMPACT:** Assessment of infra still needed and routes need to be fixed and planned to drive shuttles. HD maps are produced over and over in very pilot.
- **DEPLOYMENT:** Platooning technology still waiting for deployment and business cases. Cooperation with companies, government and knowledge institutes is needed, so is a learning by doing approach, but in practice this is quite new to all stakeholders.
- **HUMAN FACTORS:** Local involvement and trust building requires an on-going attention. Aiming for level 4 is hard but better than the incremental approach.

**THE COMPLEXITY OF AUTOMATION**  
TO CONTROL THE APPLICATION ENVIRONMENT OR NOT? THAT'S THE QUESTION

Street	Infrastructure	Street	Infrastructure	Street	Infrastructure
Controlled Environment		Semi-controlled Environment		Uncontrolled Environment	
Access	Behavior	Access	Behavior	Access	Behavior

Combination of Use cases:

- Clustering: airports, care, specific groups to transport
- Share experience/knowledge and funds: shuttles, control room and stewards
- Define and work with one Business Model Calculation methodology.
- Ask the blunt questions: Who really wants a transport service?
- Ask the blunt questions: Willingness to pay for implementation and testing?

**Key conclusions**

- **Infrastructure**
  - LIDAR's used for localisation need sufficient landmarks
  - No interaction with traffic lights, road markings, road signs,...
- **Limitations of trajectory**
  - Fixed, preprogrammed trajectory
  - Limited speed
- **Sensitive sensors**
- **Interaction with other road users and obstacles**
  - Limited possibilities (slow down, stop, emergency stop)
  - Supervisor in shuttle is needed

**Learning experiences**

- Challenge to...
  - negotiate (justified) regulators' reserves
  - overcome mutual competition of local actors
  - handle (or circumvent) restrictive PT concession regulations
  - discover the true performance of AD's; needs a critical look at press and PR publications
- Need for more realistic expectations regarding capabilities of AD in mixed traffic on the short

**Connected and Autonomous Vehicle Trials in London - February 2018**

**VEHICLE DESIGN**  
DEVELOPING OVER TIME

figure 3, presentation highlights



## 4. Generic Use Case: PODs in the Netherlands

### 4.1. Introduction

#### Background

The development and implementation of Connected and Automated Vehicles (CAVs) is important to improve road safety, traffic flows, social inclusion and the environment. In the Netherlands, RDW grants waivers for CAVs on the road. The assessment of these CAVs is orchestrated by RDW. RDW follows a law-based procedure that involves road authorities and possibility scientific research institutes like SWOV.

This chapter provides a guideline for granting exemption for so-called self-driving shuttle buses or POD-applications (hereafter called PODs). The PODs are intended primarily to shuttle passengers between two fixed points on usually a short distance in quiet traffic or separated from other traffic.

The PODs usually link with other transport hubs, such as airport shuttle buses and conferences. The PODs use HD maps, radar, lidar and cameras to safely find their way. In most cases, a safety driver is in the POD. Well-known manufacturers are EasyMile, Navya, 2getthere and Local Motors.

#### Permits

Permits are granted on the decision exemption for automated vehicles<sup>1</sup>. The legal base follows a procedure where RDW, SWOV and road authorities assess the application (see Annex 2). The risk analysis for granting the permit and/or the waiver is based on a Hazard Analysis & Risk Assessment (HARA). The HARA provides a quantification of the safety goals (applied in the ISO 26262) and these are the safety goals that applicants must meet. For a number of risk mitigation measures this document gives an appreciation or use spectrum.

#### Goal

This document provides a guideline for granting exemption for so called self-driving shuttle buses or POD-applications. To improve comparability and significance of the guideline, it was assessed against the FESTA handbook.

### 4.2. Generic uses cases for PODs

In the past decades, numerous demonstrations with PODs took place in Europe. One of the bigger ones was CityMobil2 framework that would allow ART on urban roads.

CityMobil2 work plan was organised in two phases. In the first phase, the study phase, 12 cities studied ART insertion in their sites and prepared proposals to host a demonstration. At its general objectives included the organization of demonstrations of Automated Road Transport (ART) in seven European cities; the study of long-term socio-economic impact of automating mobility; and the definition of a legal

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<sup>1</sup> <http://wetten.overheid.nl/BWBR0039791/2017-07-19>

the same time, the research team prepared technical specifications for the ART fleets to be used in the project demonstrations. Five ART manufacturer partners in the consortium prepared their bids on the basis of such specifications. Two fleets of 6–10-passenger vehicles each were selected.

During the second phase, the demonstration phase, two procured fleets (from project partners Robosoft and EasyMile respectively) were brought in the seven selected cities for variable periods to supply real transport services.

Automated transport systems were in operation even before CityMobil2 (e.g. the Rivium Parkshuttle, the Masdar and the Heathrow PRT) but they required partly or completely segregated infrastructures and are certified as if they were automated railways. CityMobil2 demonstrated that similar technologies can operate on the roads with slight modifications and with the right certification procedure. However, at the time, at slow speeds.

Mainly after 2016, many demonstrations took place in the Netherlands. This can be explained by the Dutch presidency of the council in 2016 that created a lot of media attention. Next to that, the number of POD manufactures and potential market-ready models increased.

The Dutch demonstrations were initiated by municipalities, cities and regions.

Field Operational Tests (FOT) are large-scale testing programmes aiming at a comprehensive assessment of the efficiency, quality, robustness and acceptance of ICT solutions used for smarter, safer and cleaner and more comfortable transport solutions, such as navigation and traffic information, advanced driver assistance – and cooperative systems.

The FESTA handbook defines a “Field Operational Test” (FOT) as a study undertaken to evaluate a function, or functions, under normal operating conditions in environments typically encountered by the host vehicle(s) using quasi-experimental methods.

This means that it must be possible to compare the effects that the function has on traffic with a baseline condition during which the function is not operating.

Connected Autonomous Vehicle (CAV) systems are allowed in Netherlands by a waiver or a permit. For the assessment of these systems a procedure is in place in which vehicle, road/infrastructure and behaviour is included in the evaluation of the safety system. The evaluation of the safety is based on a Hazard Analysis & Risk Assessment (HARA) and the required Safety Goals. In practice, the CAV systems can be categorized with their specific nature, as for example Highway Pilot functionality and POD-applications. Within these categories, the application operate under comparable circumstances and this can be described in a generic use case.

By describing generic use cases and the safety requirements, the RDW [SWOV and road administration] intent to give clarity on the assessment of POD-applications.

Most likely, as the generic use-cases do not cover the complete application, specific additions for the application will be necessary.

## Risk Assessment (ISO 26262)

Annex II lists the relevant section of ISO 26262. Figure 3 gives an overview of the method. The "EVENTS", "Acceptable Risks" of Safety Goals are determined in the generic Use cases ISO26262. The method follows the analysis of dangerous situations and the assessment of the risks involved, the HARA (HARA = Hazard Analysis and Risk Assessment). This is one of the methods to quantify dangerous situations. The generic use cases contain dangerous situations. The risk arising from the dangerous situations is quantified by the ASIL rankings. It uses the following formula:

$$Risk = f(S, C, E)$$

With,

S = Severity (Dutch: Ernst)

C = Controllability (Dutch: Beheersbaarheid)

E = Exposure (Dutch: Blootstelling)

The variables in the formula are explained in ISO26262-2011. To illustrate see table (Figure 2) for the Severity.

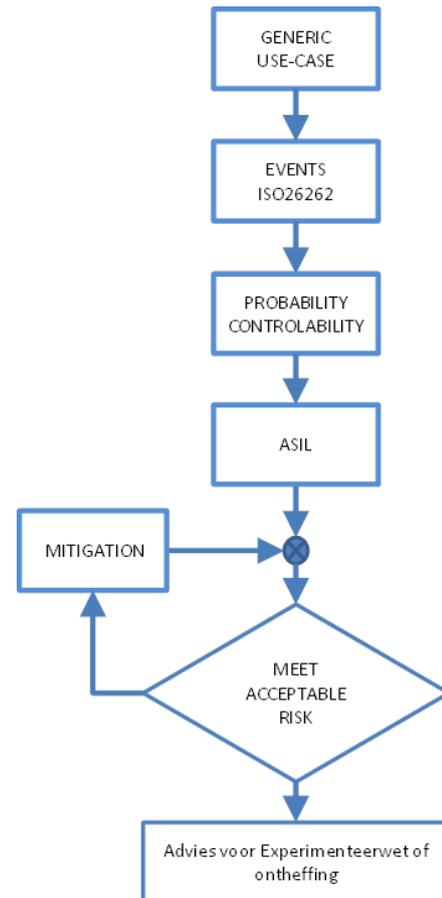


Figure 2: Process flow risk assessment

	Class			
	S0	S1	S2	S3
Description	No injuries	Light and moderate injuries	Severe and life-threatening injuries (survival probable)	Life-threatening injuries (survival uncertain), fatal injuries

Figure 2: Risk classification according to ASIL (Severity). ISO26262-2011 Part 3

The Severity-classes (severity of the risk) in figure 2 is derived from the MISRA-rankings. MISRA has also added a class S4 in which S3 is applicable to more than one person. This is not considered in ASIL. In many cases the generic Use Cases can be connected to a safety goal and hazard, but they can only be qualified for the Severity. Exposure and Controllability are very application and solution specific. By influencing the Exposure and the Controllability of the POD application, the application can meet the acceptable risks.

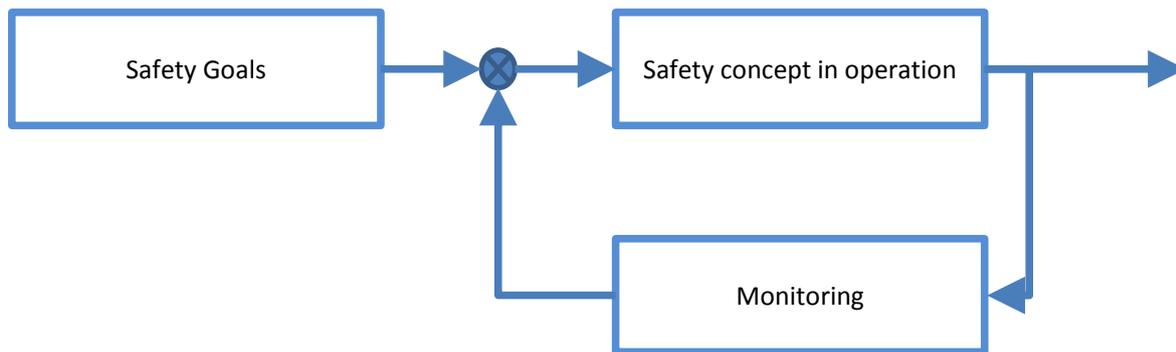


Figure 3, Safety Goals, Safety Concept and Monitoring

The Safety concept of the POD-application shall be described by the applicant. It consists of a risk assessment, an analysis of the impact of the risks and the mitigating measures to make the risks acceptable, this is focused on the actual application (not generic). The safety concept of the POD-application needs to comply with the accepted risk-levels (safety goals), see below. Because the POD-applications have an experimental character (from entrance perspective) RDW accepts the safety concept with its principles and assumptions. During the operational phase of the waiver or license objective monitoring needs to confirm that the safety concept is realized in the application. Digital logging of the application and PODs is a big advantage.

### Acceptable risk (safety goals)

After implementation of the risk mitigating measures, the resulting risk needs to meet the QM-level (in ASIL).

Safety Goal = QM

Controllability C	Exposition (E)	Severity (S)			
		S0	S1	S2	S3
C1	E1	QM	QM	QM	QM
	E2	QM	QM	QM	QM
	E3	QM	QM	QM	A
	E4	QM	QM	A	B
C2	E1	QM	QM	QM	QM
	E2	QM	QM	QM	A
	E3	QM	QM	A	B
	E4	QM	A	B	C
C3	E1	QM	QM	QM	A
	E2	QM	QM	A	B
	E3	QM	A	B	C
	E4	QM	B	C	D

### Additional requirements

In addition to the parts of the ISO26262 that are about the risks of the POD-application, the following components of the ISO26262 are mandatory to obtain the waiver or license: the user of the

- Overarching safety management

- The applicant will guarantee safety management over the entire period of the permit or exemption
- independent and objective assessment of the safety
- results of monitoring show that the safety case is effective as is intended
- Configuration management
  - the application and relevant parts of this are uniquely identifiable
  - based on the configuration management is the behaviour of the vehicle with different software versions is traceable and reproducible
- Change Management the
  - The organization of the applicant has knowledge, authority and budget to make necessary changes.
- Admission requirements for vehicles (for example, the individual requirements)

### 4.3. Vehicle related risks

Next to the CAV aspects, also the general vehicle related safety risk apply. You can think of

- Passive Safety (Belts and Sharp parts)
- Active safety (functionality of automatic use)
- Electric system (hi-voltage)

This is part of the regular safety assessment and will therefore not be elaborated. It should be mentioned PODs are not part of the current harmonized European framework directive. The EC is calling for action to come with standards for PODs <sup>2</sup> The issues that have to be addressed may require fundamental changes as the current rules are designed on the assumption that a

### 4.4. Generic items for research

#### Closed road for POD

One-way road

HARA	Event	Severity		
		<30km/h	30-50km/h	>50km/h
Hazard/danger				
Unintentionally steering	Vehicle drives off the track and collides	S1	S2	S3
Unintentionally speeding	Situation unsure and collision.	S1	S2	S3
Unintentionally braking	Risk of traffic behind	S1	S1	S2

Exposure

When driving on a one-way road, the vehicle is constantly exposed to these hazards. The Exposure is therefore high (E4)

Controllability

---

<sup>2</sup> [https://ec.europa.eu/growth/content/high-level-group-gear-2030-report-on-automotive-competitiveness-and-sustainability\\_en](https://ec.europa.eu/growth/content/high-level-group-gear-2030-report-on-automotive-competitiveness-and-sustainability_en)

A fully automated vehicle does not have a person who can intervene, therefore the controllability also scores high (C3)

Two way road

HARA		Severity		
Hazard/ danger	Event	<30km/h	30-50km/h	>50km/h
Unintentionally Steering	Vehicle collides with oncoming vehicle	S2	S2-S3	S3
Other as a one-way				

### Closed road with intersection of normal traffic

- Different priority situations
- Traffic Light

### Turns

#### Bus stop related

- Stopping
- Driving away
- Priority and behaviour
- Special situation
  - Water
  - Holes in the road
- Mixed traffic
  - One-way road/ separated lanes
  - Two way road
  - Unpredictable traffic behaviour of third parties (e.g. cyclists and pedestrians, great manoeuvrability)
  - Priority situations in mixed traffic
  - Intersections in mixed traffic
  - Bus stop related situations
- Expectation of other road users
  - Recognisability pod
  - Recognisability POD-trajectory
  - Recognisability intersection with POD-trajectory
  - Abuse
    - Unintended
    - Joke
    - Sympathy factor

## 4.5. Vehicle related risks

### Vehicle

Kinetic energy in the event of a collision

- Speed
- Mass
- Related to the need for a belt

- Experience of public transport company's
- Speed reduction in case of collision
  - Seats
  - Standing places
- (Cyber) Security issues
  - Method
    - Minimal surface of contact
    - Monitor intrusion
    - Counter measures installed
  - Transparent white hacker bonus
  - Recognisability and marking as POD
  - The vehicle communicates its status and intentions via a screen

## Surroundings

- Traffic
  - Intensity (quantification)
    - Rush-hour (differences during the day )
  - Nature of traffic
    - Harbour
    - City
    - Campus
    - Province
- Road surface
- Width of the road
- Speed other traffic (or difference)
  - Keeping up the same speed
  - Driving another speed
- Intersection
- Exit
- Priority situations
- Deep holes in the road /Docks /Water(electricity)
- Obstacles
- Visibility and weather conditions (daylight, low sun, snow, rain)

## Behaviour of road users

- Unfamiliarity of the interaction with a pod
- Jokes/provocation

### Events (Safety related)

- Insight the vehicle (passive safety)
  - Asking Public transport companies questions about accident statistics as a reference for the PODs
    - Busses are being hit
    - Busses hitting another vehicle
- 
- Outside the vehicle (active safety)
- Electric safety (R100)
- ASIL Class of events
- Frequency of preventing an event
- (Probability en Exposure)
  - Monitoring

## 4.6.Mitigating measures

### Vehicle measures

#### Belts

Properly confirmed and approved three-point belts have the following mitigating value

Speed	<30 km/h	30-50 km/h	50-80km/h
Collation	S0	S1	S2

Additional condition is that the occupant in the belt does not hit sharp or hard parts in the car in the event of a collision.

#### Interior clothing

Soft upholstery inside vehicle (eg foam in permanent good condition), damped by experiment.

Speed	<30 km/h	30-50 km/h	50-80km/h
Collation	S0	nvt	nvt

#### Driver as back up

If the driver is well-trained and it is demonstrable that the driver has the means and reaction time to intervene in the event of a hazard:

Controllability is category C1

#### Redundant systems

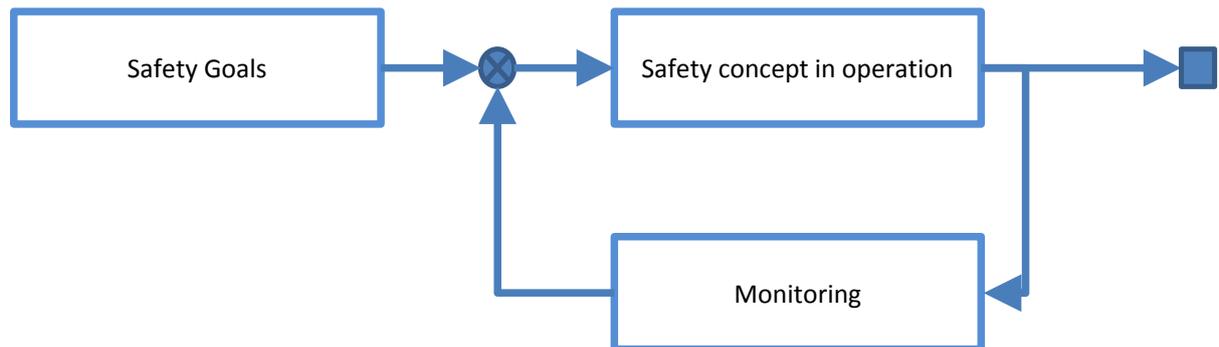
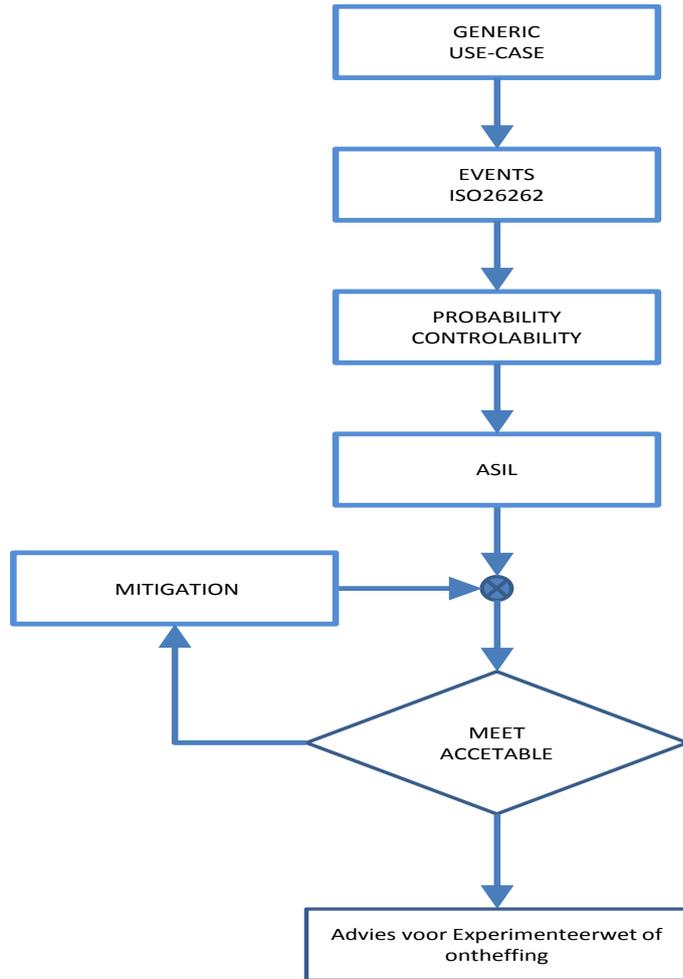
An automatic system is only seen as a back-up if it works completely independently.

- power
- Sensors, algorithms that apply sensor fusing are dependent on multiple sensors and are not considered redundant

#### Safe by design

The risk exposure is reduced by reducing the time of exposure

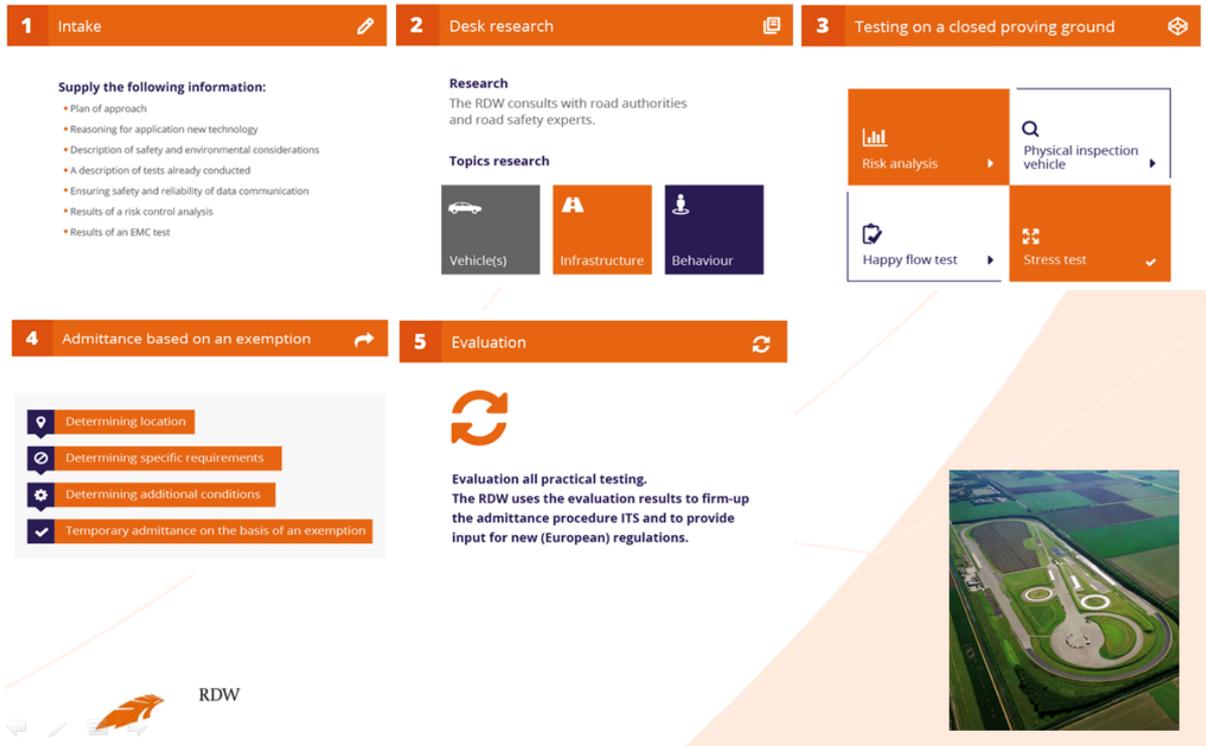
# Infrastructure



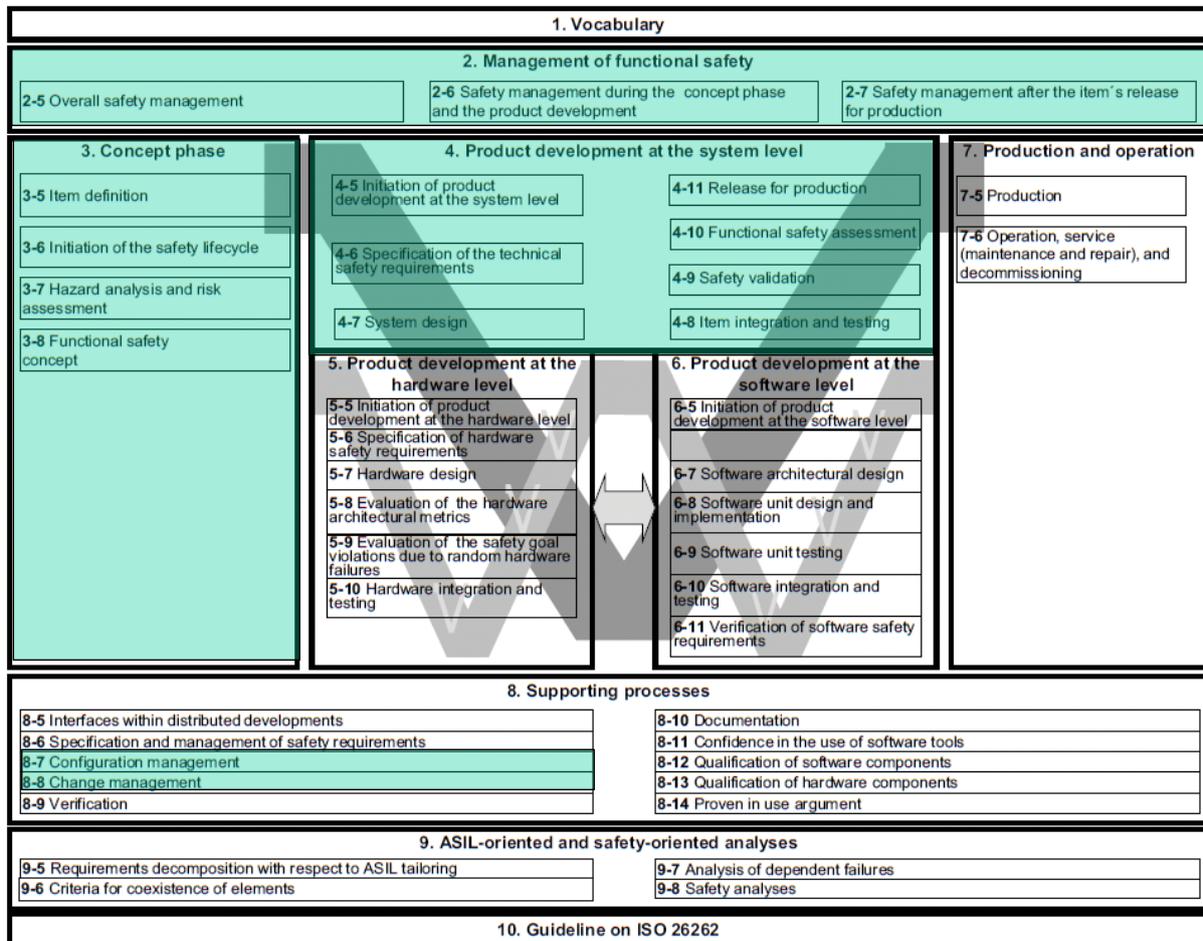
## 5. Annexes

### 5.1. Annex 1; process for exempting CAD Vehicles

# Exemption process



## 5.2. Annex 2; sections ISO26262



### 5.3. Annex 3; information document for obtaining individual approval of a EC category vehicle M1-M2-M3-N1-N2-N3



RDW

Make / type:	Completely filled in truthfully
Identification nr.:	Name:
EC cat. ( see 2007/46/EC Annex II A):	Date:
Body work ( see 2007/46/EC Annex II C):	Signature:

	DIRECTIVE EC	EC / EU Regulation*	SUBJECT	M1	M2	M3	N1	N2	N3	
	2007/46		EC-WVTA Multi stage							
1	70/157	R51	Sound levels	X	X	X	X	X	X	
2	70/220		Emissions	X	(1)		X	(1)		
2a	715/2007		Emissions ( Euro 5 and 6) light-duty vehicles	(1)	(1)		(1)	(1)		
3a.	70/221	R34	Fuel tanks	X	X	X	X	X	X	
3b.	70/221	R58	Rear protective devices	X	X	X	X	X	X	
4	70/222	1003/2010	Rear registration plate space	X	X	X	X	X	X	
5	70/311	R79	Steering effort	X	X	X	X	X	X	
6	70/387	R11 & 130/2012	Door Latches & Hinges	X			X	X	X	
7	70/388	R28	Audible warning	X	X	X	X	X	X	
8	2003/97	R46	Indirect vision devices	X	X	X	X	X	X	

9	71/320	R13 & R13-H	Braking								
				X	X	X	X	X	X		
10	72/245	R10	EMC/ Suppression ( radio)	X	X	X	X	X	X		
11	72/306		Diesel smoke	X	X	X	X	X	X		
12	74/60	R21	Interior fittings	X							
13	74/61	R116	Anti-theft and immobiliser	X	(2)	(2)	X	(2)	(2)		
14	74/297	R12	Protective steering	(3)			(3)				
15	74/408	R17	Seat strength	X	X	X	X	X	X		
15B		R80	Seats of large passenger vehicles		X	X					
16	74/483	R26 (& R61)	Exterior projections	X							
17	75/443	R39	Speedometer + reverse gear	X	X	X	X	X	X		
18	76/114	19/2011	Plates ( statutory)	X	X	X	X	X	X		
19	76/115	R14	Seat belt anchorages	X	X	X	X	X	X		
20	76/756	R48	Installation of lighting & light signalling devices	X	X	X		X	X	X	
21	76/757	R3	Retro reflectors	X	X	X	X	X	X		
22	76/758	R7 & R87 & R91	End-outl., fr.pos (side), repos (side), stop,side m., daytime run. lamps	X	X	X	X	X	X		
23	76/759	R6	Direction indicators	X	X	X	X	X	X		
24	76/760	R4	Rear registration plate lamps	X	X	X	X	X	X		
25	76/761	R31 & R37 & R98 & R99 & R112 & R123	Headlamps ( including bulbs)	X	X	X	X	X	X		
26	76/762	R19	Front fog lamps	X	X	X	X	X	X		
27	77/389	1005/2010	Towing hooks	X	X	X	X	X	X		
28	77/538	R38	Rear fog lamps	X	X	X	X	X	X		
29	77/539	R23	Reversing lamps	X	X	X	X	X	X		
30	77/540	R77	Parking lamps	X	X	X	X	X	X		

31	77/541	R16	Seat belts	X	X	X	X	X	X	
32	77/649	R125	Forward vision	X						
33	78/316	R121	Identification of controls	X	X	X	X	X	X	
34	78/317	672/2010	Defrost/demist	X	(7)	(7)	(7)	(7)	(7)	
35	78/318	1008/2010	Wash/wipe	X	(8)	(8)	(8)	(8)	(8)	
36	2001/56	R122	Heating system	X	X	X	X	X	X	
37	78/549	1009/2010	Wheel guards	X						
38	78/932	R25	Head restraints	X						
39	80/1268		CO <sub>2</sub> emission, fuel consumption	X			(4)			
40	80/1269	R85 (13)	Engine power	X	X	X	X	X	X	
41	2005/55		Diesel Emission (Euro IV and V)	X	X	X	X	X	X	
41B		595/2009	Emissions (Euro VI)		(14)	(14)		(14)	(14)	
42	89/297	R73	Lateral protection					X	X	
43	91/226	109/2011	Spray suppression systems					X	X	
44	92/21	1230/2012	Masses and dimensions ( cars)	X						
45	92/22	R43	Safety glass	X	X	X	X	X	X	
46	92/23	R30 & R117 & R64 & R54	Tyres							
				X	X	X	X	X	X	
47	92/24	R89	Speed limiters		X	X		X	X	
48	97/27	1230/2012	Masses and dimensions (other than vehicles referred to initem 44)		X	X	X	X	X	
49	92/114	R61	External projections of cabs				X	X	X	
50	94/20	R55	Couplings	(9)	(9)	(9)	(9)	(9)	(9)	
51	95/28	R118	flammability		X	X				
52A	2001/85	R107	Buses and coaches		X	X				
52B		R66	Strength of the superstructure		X	X				
53	96/79	R94	Frontal impact	(11)			(11)			
54	96/27	R95	Side impact	(10)			(10)			
55	(empty)									
56	98/91	R105	Vehicles intended for the transport of dangerous goods				(12)	(12)	(12)	

57	2000/40	R93	Front Underrun Protection					X	X	
58	2003//102		Pedestrian protection	(11)			(5)			
59	2005/64		Recyclability	X			X			
60	2005/66		Frontal protection system	X			X			
61	2006/40		Air-conditioning system	X			(6)			
62	79/2009		Hydrogen system	X	X	X	X	X	X	
63		661/2009	General Safety							
64		65/2012	Gear shift indicators							
65		347/2012	Advanced emergency braking system		X	X		X	X	
66		351/2012	Lane departure warning system		X	X		X	X	
67	R67		LPG	X	X	X	X	X	X	
68		R97	Vehicle alarm systems (VAS)							
69	R100		Electric safety	X	X	X	X	X	X	
70	R110		CNG	X	X	X	X	X	X	
	Bijlage IV artikel 2 lid 2b Bijlage IX		Deugdelijkheid en weggedrag							

\* Mandatory: 01-11-2012 for EC type approval of new types of vehicles . 01-01-2014 for Individual approval

- (1) For vehicles with a reference mass not exceeding 2 610 kg. At the manufacturer's request may apply to vehicles with a reference mass not exceeding 2 840 kg.
- (2) Optional for other categories, has to comply when fitted
- (3) < 1.500 kg.
- (4) N/A for N1 if both:
  - The engine type fitted to that type of vehicle has received type approval pursuant to Directive 88/77/EEC, and
  - The total annual worldwide production of N1 vehicles of the manufacturer is less than 2 000 units.
- (5) ≤ 2.500 kg. or derived from M1 category vehicles
- (6) With reference mass ≤ 1.305 kg.
- (7) Adequate windscreen defrosting and demisting device
- (8) Adequate windscreen washing and wiping devices

- (9) The requirements of Directive 94/20/EC shall apply only to vehicles equipped with couplings.
- (10) Only applicable to vehicles where the “Seating reference point (‘R’ point)” of the lowest seat is not more than 700 mm high above the ground level. The “R” point is defined in Directive 77/649/EEC.
- (11) Not exceeding 2,5 tonnes technically permissible maximum laden mass.
- (12) The requirements of Directive 98/91/EC shall apply only when the manufacturer applies for the type-approval of a vehicle intended for the transport of dangerous goods.
- (13) In case of vehicles equipped with an electric power train,

## 5.4. Annex 4: Workshop presentations

# 2getthere's delivery record

- >14 million passengers delivered
- Delivery of multiple 1st systems
- Delivering a vehicle reliability and system availability >99.7%



[ we deliver ]



# VEHICLE DESIGN

## DEVELOPING OVER TIME

Development brief:  
Design a vehicle that resembles a bus, to be familiar to people as public transportation

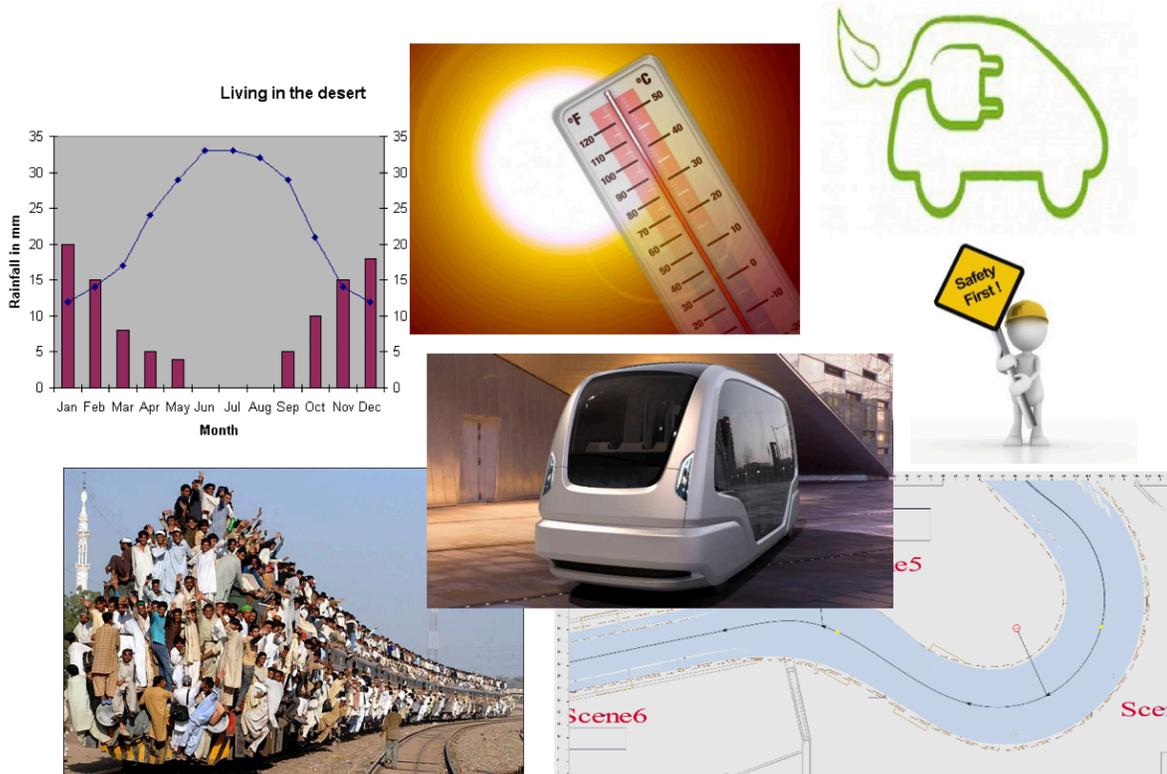


Development brief:  
Design an iconic vehicle, that resembles the future of transportation



# 3<sup>RD</sup> GENERATION GRT DEVELOPMENT

## MAIN OBJECTIVES



- Minimal infrastructure footprint
- System life: 20 years
- Sustainable mobility
- High passenger comfort
- Extreme environmental conditions
- Innovative design
- High system capacity
- Safety

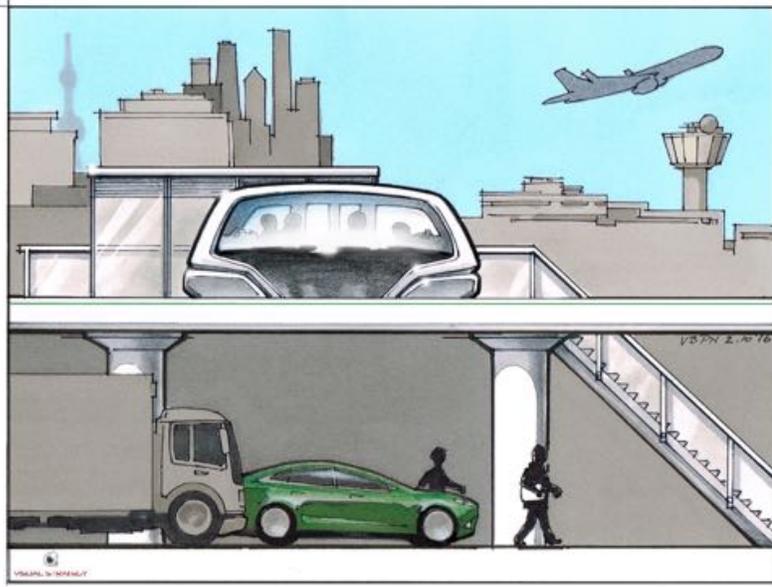
# THE COMPLEXITY OF AUTOMATION

TO CONTROL THE APPLICATION ENVIRONMENT, OR NOT? THAT'S THE QUESTION



# DIFFERENT AUTOMATED APPLICATIONS

IN RELATION TO THE ENVIRONMENT AND THE CAPACITY TO BE ACHIEVED



Automated People Movers (APM)



Automated Transit Networks (ATN)



Shared Autonomous Vehicles (SAV)

**THANK YOU.**  
ANY QUESTIONS?

[we deliver]





**Future  
Mobility  
Network**



**ADaaS**

The learning by doing approach  
scaling up by gathering several use cases

NO CHANGE WITHOUT A

**AABEL**



# Situation Netherlands

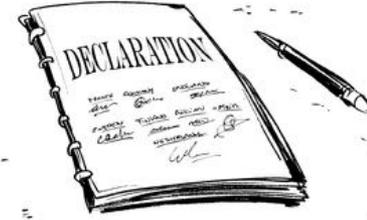


Just a few observations:

- Public transport in rural areas shrinking due to focus on affordability
  - Aging with greater demand for care as a result
  - Road and public transport networks are filled and full rapidly
  - Increasing desire to have urban area green and healthy -> less space for private cars?
  - Shopping centers larger and different
  - More and more remote parking (airports, amusement parks, hospitals?)
- 
- Current systems can not meet the changing needs for mobility
  - Market (OEMs) developing rapidly
  - There is a need for a new mobility concept for the last mile!



# European Agenda

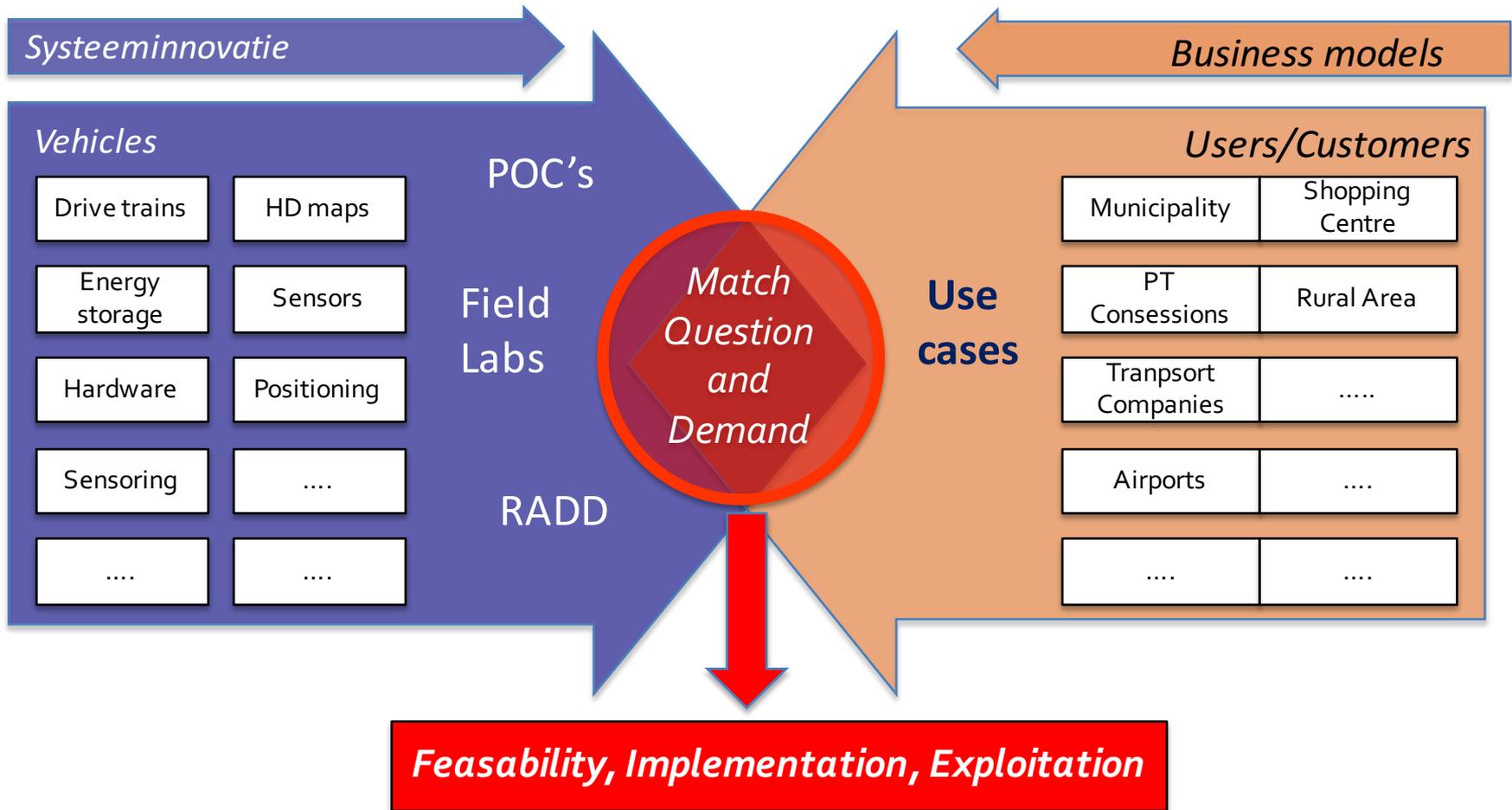


## Joint Agenda

- **Work towards a coherent European framework by 2019** for the deployment of interoperable connected and automated driving;
- **Adopt a “learning by doing” approach, including cross-border testing and cooperation**, sharing and expanding knowledge on connected and automated driving and to develop practical guidelines to ensure interoperability of systems and services;
- **Support further innovation** in connected and automated vehicle technologies to strengthen the global market position of European industry;
- **Data sharing** is important for purposes of learning and allowing third parties to deliver services **...while ensuring privacy**, which requires us to make this a priority from the start.



# Technology road map vs business cases

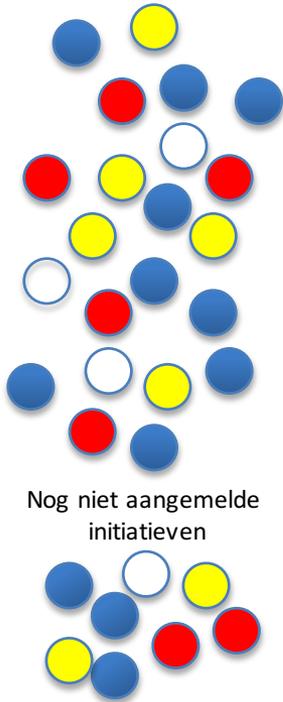




# ADaaS Approach NL

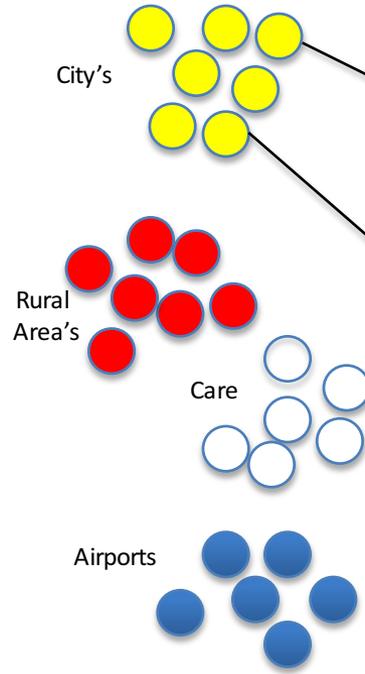


Approval Requests

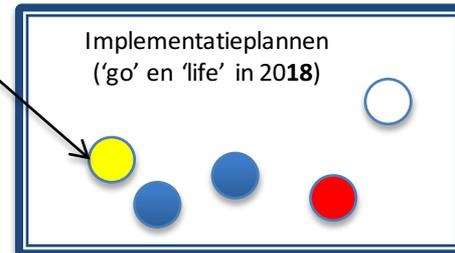
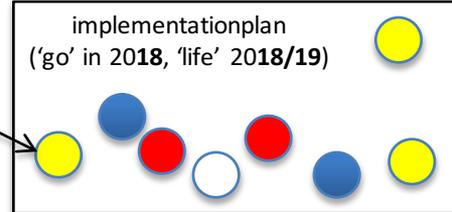


Screening / functionele clustering naar PMC's

Product Market combinations  
CAV



Van long list naar short list (2018)



Target  
(3-5 jaar)

25-50 vehicles  
(shuttles)

25-50 vehicels  
(shuttle/robottaxi)

50 - 100 shuttles

+

Road Readiness (RDW test-week)

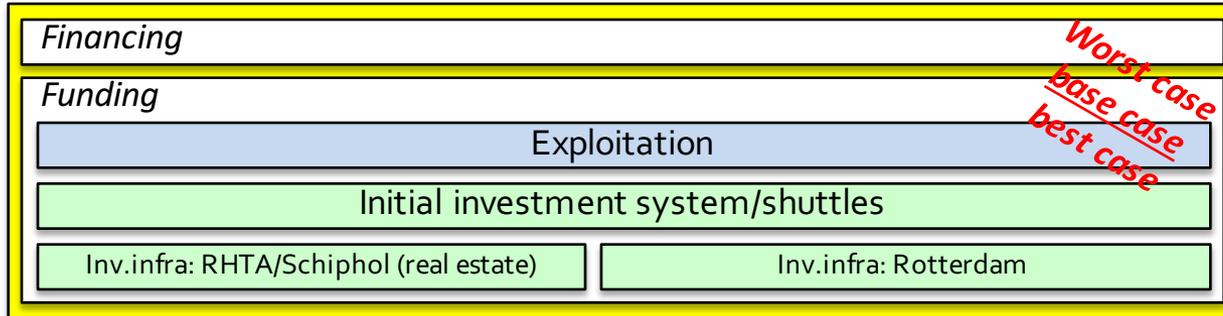
Market scan (capacity, speed etc)

Conditions (regulations etc)



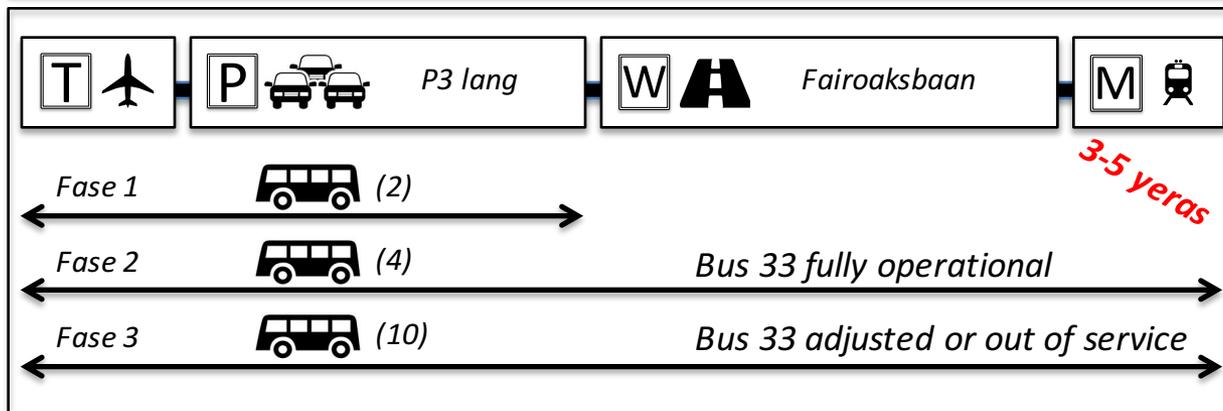
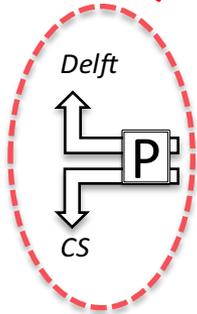


# Implementation plan Rotterdam The Hague Airport- RTHA



Investment proposal

*In future?*



Route and infra demands

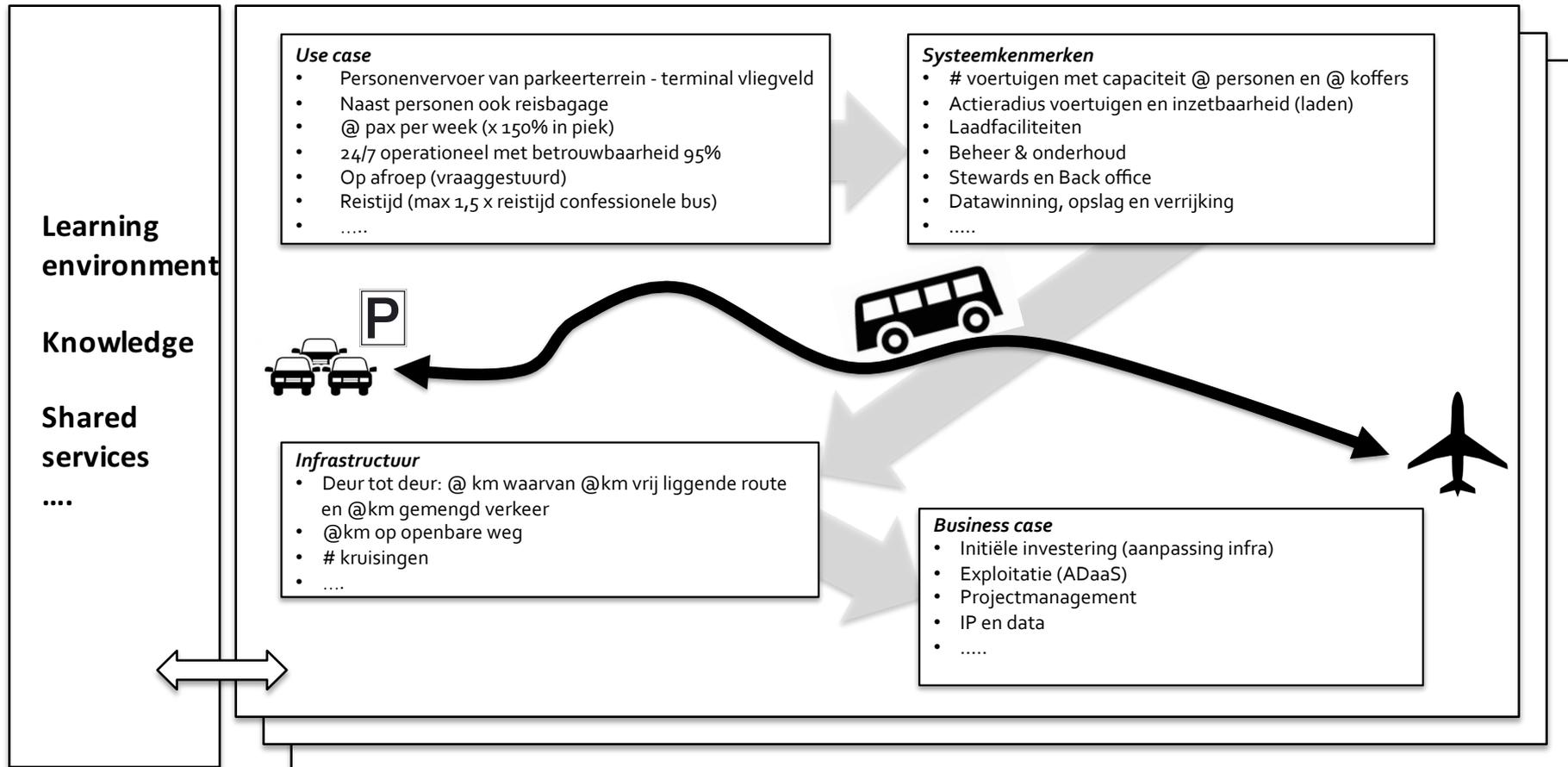
System Demands



Agreement to Cooperate



# Doing and learning





# Acceleration in Netherlands (use cases)



## Feasibility-studies:

- Municipality of Drimmelen.
- Municipality of Sluis.
- Municipality of Amsterdam (IJburg).
- Municipalities MRDH, including Capelle, Schiedam, Delft, Rijswijk, The Hague e.a.
- At airports: Schiphol, Rotterdam and Eindhoven.
- Other: ESA Estec Space Center.
  
- Preparation phase underway: Rivium Shuttle Capelle, WEPODs and I-AT
- In 2017 there was no vehicle on the road.
- In 2018 we expect 3-5 use cases to drive on public roads.

# Lessons Learned 2017/2018



## For a single Use Case

- Know area, fixed route 0,5-10 km, 10-20 km/h
- Several parties must work together.
- Put use case owner in the lead not the local government.
- Stages: (pre-)feasability, joint commitment, implementation, exploitation.
- Agreements for a longer time period, and be flexible, open and innovative.

## Combination of Use cases:

- Clustering: airports, care, specific groups to transport
- Share experience/knowledge and funds: shuttles, control room and stewards
- Define and work with one Business Model Calculation method/tool.
- Ask the blunt questions: Who really wants a transport service ?
- Ask the blunt questions: Willingness to pay for implementation and testing?

# Interregional Automated transport NL - DE

Joop Veenis (Veenis.net)  
namens lead partner  
Provincie Gelderland  
Februari 2018- Rijkswaterstaat



[www.i-at.eu](http://www.i-at.eu) Visit the site!



Europäische Union  
Europese Unie

# Presentation Outline

---

- goal and description of pilot I-AT
  - Continue development of WEPOd shuttles by Province of Gelderland and partners
  - Make the NL-DE border region a better place
  - Do the impossible: drive legally automated cross border in the EU
- research objectives?
  - Discover new automated public transport and logistics solutions in region
  - Prepare the WEPOd for large scale deployment: robust, safe and affordable
  - Investigate and help to Harmonise regulations in real live living lab X-Border automated bus line
- if so, what sources of data collection:
  - The Dutch 'learning by doing' approach and streetwise experience true living labs
  - Knowledgeagenda.connekt.nl and document collection in Dropbox (just join!)
- plans to evaluate and or document lessons learned?
  - Yes, Annual reports lessons learned shared online (Dropbox) and thru meetings in NL and DE.

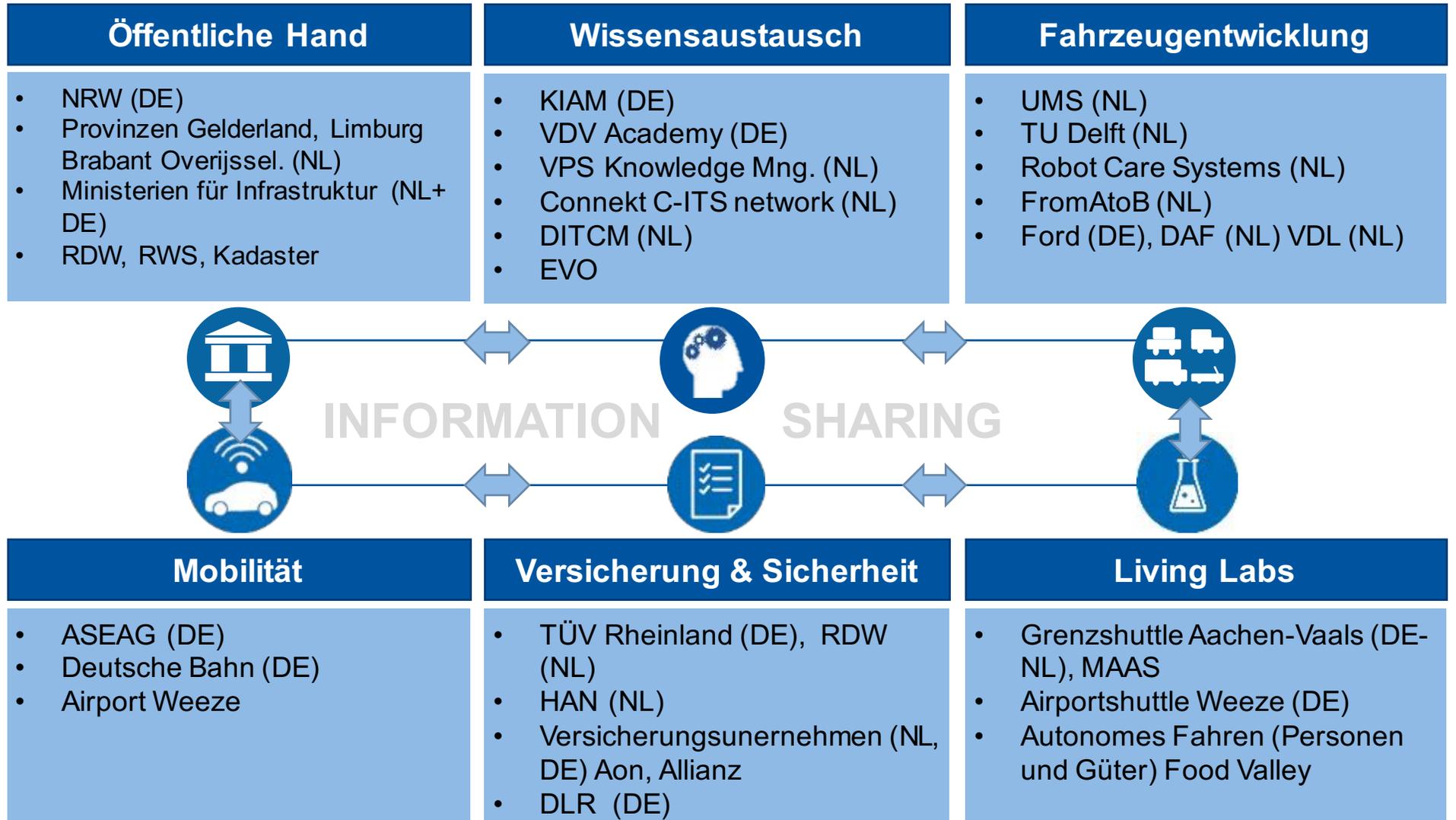
## Warum: dieses projekt im Interreg?

---

- Deutsch-niederländisches Grenzgebiet = wichtigster Verkehrsknotenpunkt in Europa
- Selbstfahrende Autos und Lastwagen sollen die Gesellschaft und die Wirtschaft verändern, was Auswirkungen auf die INTERREG-Region haben wird
- NRW ist der Nummer 1 Logistik-Hotspot in Europa, aber: unzureichend qualifiziertes Personal und niedriger Innovationsgrad
- Darum: Brennpunkt der Region; wichtig: technologische Weiterentwicklung in der Automobil- und Verkehrsbranche mit vielen kleinen und mittelgroßen Projekten!



# Innovation platform connecting small and larger business with knowledge



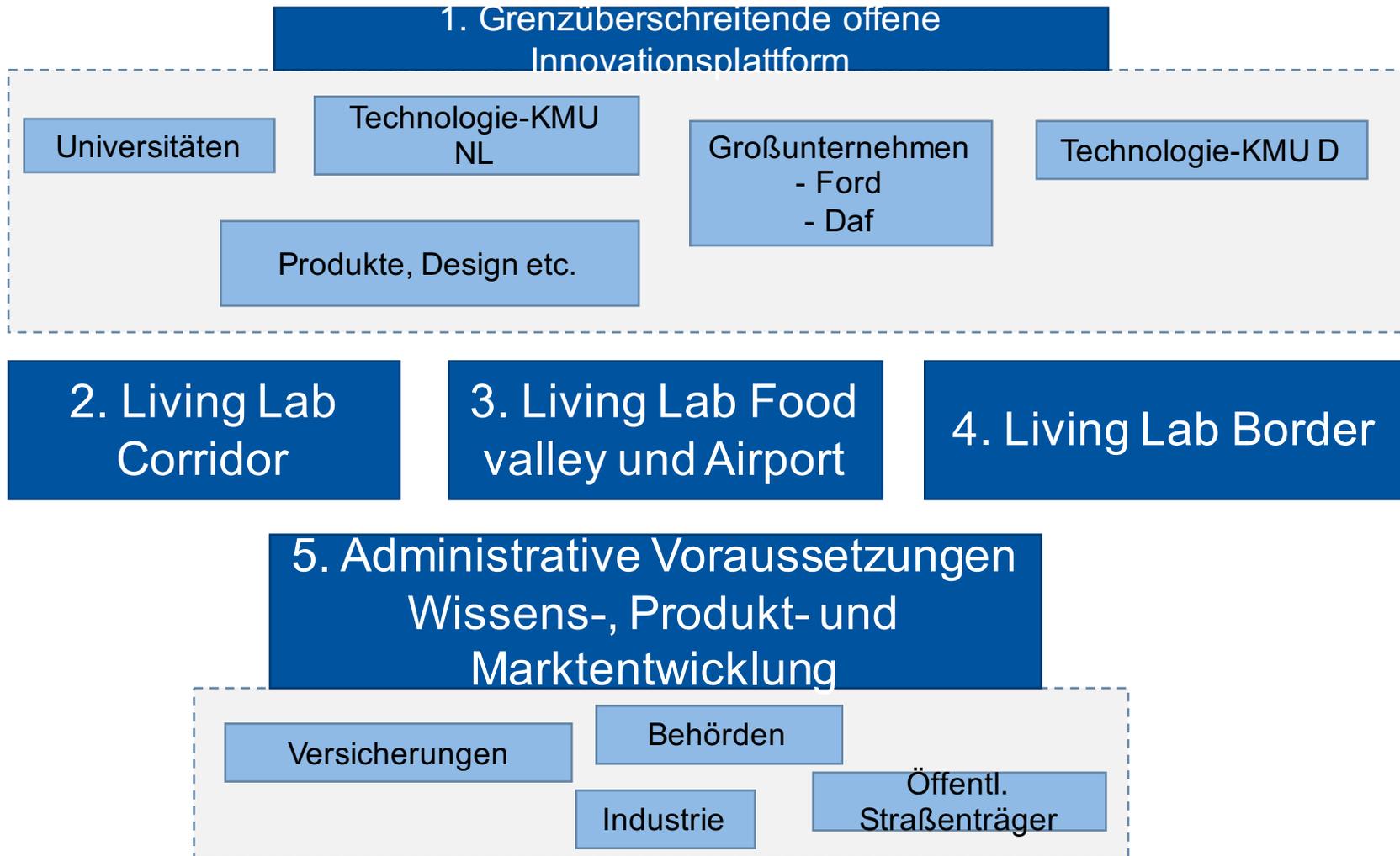
# Finanzen

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- Geambudget: € 8,7 mio, € 5,5 mio Personal en € 3,3 mio Sonstige Kosten
- INTERREG-Finanzierung: € 5,6 mio (64%)
  - EFRE € 3,5 mio
  - Ministerie van Economische Zaken € 0,8 mio
  - MWEIMH NRW: € 0,8 mio
  - Provinz Gelderland: € 0,4 mio
  - Provinz Limburg: € 0,05 mio
  - Provinz Noord-Brabant: € 0,07 mio
  - Provinz Overijssel € 0,03 mio
- Eigenbeitrag: € 3,2 mio (36%)

# Wie: Von der Innovationsplattform zur Umsetzung in 6 Arbeitspaketen

6a Projektmanagement  
6b Projektsupport



# Was haben wir 2020 erreicht? Übersicht Ergebnisse Arbeitspakete

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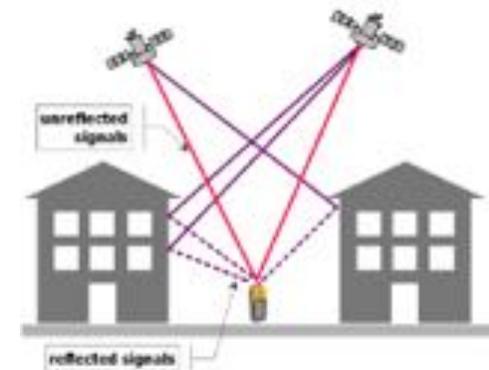
- (Technische) Produktinnovation Autonomes Fahren (WP1)
- Besserer Transport zw. NL und NRW (WP2)
- Airport-Shuttle und Foodvalley-Route: Weiterentwicklung autonomes Fahren (WP3)
- Testbetrieb und Business Case für autonomen, grenzüberschreitenden Transport von Personen (WP4)
- Straßenkarte für digitale Infrastruktur im Grenzgebiet und Business Case für Straßenmanagement, Gesetzesänderungen und Versicherungen (WP5)



# Was haben wir 2020 erreicht?

## AP 1: Besseres autonom fahrendes Shuttlebus-System durch

- Neue Sensortechnologien,
- Neue Software (Bildererkennung, Ortung, Navigation, Autopilot, Kommunikation),
- Flottenmanagement
- Zertifizierte Testprogramme
- Optimiertes Brems- und Lenksystem, robuste und sichere Fahrzeugeinrichtung.
- Schneller und in der Nacht fahren
- mehr Flexibilität bei der Routen



Spring  
innovation  
management



# Project content WEPODs-2015-2016



- WE-PODs first CAV on public Road L4 Ede-Wageingen

## • Vehicle: Easymile EZ10



### Additions:

- D-GPS/RTK + INS + Odometry
- 6 multilayer lasers for localization and objects
- 9 camera's + 9 radars + 9 ultrasonics
- 5 computers (3x Drive PX)
- Control panel
- Interior camera, Interior + exterior intercom
- 4G + 3G + Wifi-P communication
- Ticker tapes front + rear
- 12KWH batteries
- Heater, belts, head rests, roller chair
- Supervisor system
- fixation, wiper, 3rd brake light, int. covers, User App
- Steward seat, horn
- Infotainment

# I-AT New Automated Bus Development



Length: 750 cm  
Width: 220 cm  
Height: 270 cm  
Turning circle: 18.3 m diameter

Speed: 50 km/hr max.  
Capacity: up to 20 seats

Safety: All seats with 3pt belts and headrest

Sensors: Radar+camera+lidars

Access: low and flat floor wide door (110 cm)  
wheelchair ramp

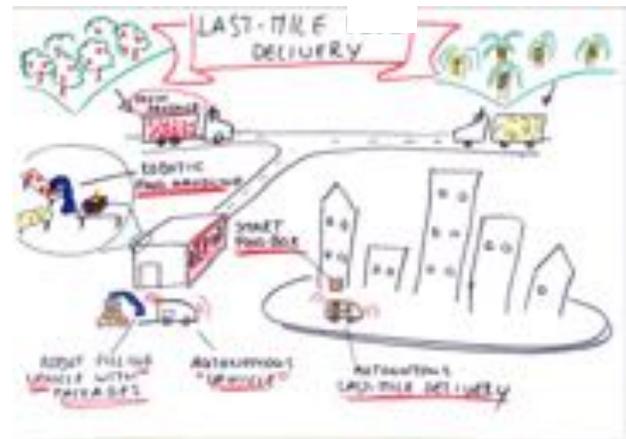
Planning:  
2018 Development  
2019 First pilot:

Aachen/Vaals

# Was haben wir 2020 erreicht?

## AP 3 Airport-Shuttle und Foodvalley-Route: Weiterentwicklung autonomes Fahren

- Flexibles Produkt für Shuttle-Transport für Personen und Güter
- Testroute Weeze-Airport und Food Valley
- Testergebnisse
- Neue Softwareprodukte
- Wissen, Schulungen, Input durch gesellschaftliche Diskussionen
- Akzeptanz durch den Verbraucher



# Was haben wir in 2020 erreicht?

---

## AP 4: Autonom fahrender Shuttlebus-Dienst D-NL

- Entwicklung grenzüberschreitende Testroute
- Versicherungsprodukte, Zertifizierungen
- Neues flexibles Produkt für den ÖPNV
- Testergebnisse
- Bewertung von Infrastruktur, Zusammenspiel zw. Innovation und Vorhandenem
- Neue Softwareprodukte und Visualisierungsmodelle



# Was haben wir 2020 erreicht?

---

## AP 5: Steigerung Wissen und Marktchancen

- Konkrete Business-Cases und Übergang von Innovationen in den Markt
- Fahrplan für die digitale Infrastruktur in der Grenzregion: Anpassungen Straße und Gesetze, Versicherungen, Erfahrungsberichte



# Netherlands and Germany work together on Interregional Automated Transport (IAT)...



Landeshauptstadt Hannover | Fachbereich Öffentliche Ordnung

**Ausnahmegenehmigung** | Antragsnummer: 01.06.2017

**antragsteller:** Herr Langel, 218, 4281, Postfach 5050, 38100 CX Anhem, NIEDERLANDE

**antrag:** 32.45

**ausnahmegenehmigung:** 01.06.2017

**Ausnahmegenehmigung gemäß § 79 der Straßenverkehrs-Zulassungs-Ordnung (StVZO)**

Sehr geehrte Damen und Herren,

aufgrund des Antrages vom 24.06.2017 in Verbindung mit den im Vorfeld des Antrages eingereichten Unterlagen zur technischen Ausstattung der Fahrzeuge, die mit experimentellen ITS-Anwendungen (Intelligente Transportsysteme) betrieben werden und die dazu vorgelegten Kopie und Übersetzung der Ausnahmegenehmigung Nr. 2016028106 des RWV erhalten wir nach § 79 Abs. 1 StVZO vom 15.11.1974 (BGBl. II 9232-1) in der z.z. gültigen Fassung sowie mit Ermächtigung des Niedersächsischen Ministeriums für Wirtschaft, Arbeit und Verkehr eine Ausnahmegenehmigung von den Vorschriften der StVZO für die Durchführung von Überführung- und Demonstrationsfahrten unter den nachstehend genannten Bedingungen.

Diese Ausnahmegenehmigung gilt allein für das nachstehend beschriebene Fahrzeug und ist nicht übertragbar.

**amtliches Kennzeichen: ZZ-98-19**  
**Fahrzeugident.-Nr.: VJRD1A1A10000015**  
**Hersteller: LIGIER**

Die Ausnahmegenehmigung wird unter folgenden Bedingungen erteilt:

Die Ausnahmegenehmigung ist nur gültig für die aus der Anlage 1 zu dieser Ausnahmegenehmigung zu entnehmenden Steckefführung und ist beschränkt auf den Zeitraum vom 06.06. bis 08.06.2017.

Die Ausnahmegenehmigung wird erst dann wirksam, wenn vorab, bei der ersten Inbetriebnahme des Fahrzeugs die Bestätigung eines Sachverständigen einer technischen Prüfstelle vorliegt, die die Betriebssicherheit des Fahrzeugs bezogen auf die vorgesehene Fahrstrecke bestätigt.

Antragsnummer	BZ	Bereit	BC	BR
001-00-00	100-000	000-000	000-000	000-000
001-00-01	100-001	000-001	000-001	000-001
001-00-02	100-002	000-002	000-002	000-002
001-00-03	100-003	000-003	000-003	000-003
001-00-04	100-004	000-004	000-004	000-004
001-00-05	100-005	000-005	000-005	000-005
001-00-06	100-006	000-006	000-006	000-006
001-00-07	100-007	000-007	000-007	000-007
001-00-08	100-008	000-008	000-008	000-008
001-00-09	100-009	000-009	000-009	000-009
001-00-10	100-010	000-010	000-010	000-010

**TUV NORD** | Mobilität

**Bestätigung zur Betriebssicherheit des Fahrzeugs WE000**  
**Hersteller LIGIER, Fahrzeug-Ident.-Nr. VJRD1A1A10000015, amtliches Kennzeichen: ZZ-98-19**

Sehr geehrter Herr Brul,

Ich konnte mich am 06. Juni 2017 vor und am 07. Juni 2017 bei der ersten Inbetriebnahme des o. g. Fahrzeugs davon überzeugen, dass die Betriebssicherheit des Fahrzeugs auf der vorgesehenen Fahrstrecke am Hannover Congress Centrum gemäß Lageplan gegeben ist.

Grundlage der Begutachtung und Prüfungen waren die Dokumente der Niedersächsischen Zulassung des Fahrzeugs, die vom RWV ausgestellte Ausnahmegenehmigung Nr. 2016028106 vom 20.12.2016 sowie die Technische Beschreibung der Funktionsweise des Systems in der Niederschrift der Besprechung am 25. Oktober 2016 der TÜV Rheinland Kraftfahrt GmbH.

Der autonome Betrieb findet ausschließlich auf der von der Stadt Hannover freigegebenen Teststrecke mit einer maximalen Geschwindigkeit von 10 km/h statt. Der anwesende Steward ist jederzeit in der Lage, die Kontrolle über das Fahrzeug manuell zu übernehmen.

Die Überführungsfahrt zwischen Teststrecke und Ladeplatz mit manueller Bedienung durch den Steward ist unbedenklich.

Anlagen: Lageplan

**Dr. rer. oec. Kerstin Baumbach**  
 Amtlich geprüfte Sachverständige für die Kraftfahrzeugprüfung  
 Technischer Prüfer TÜV NORD Mobilität

# Milestones

---

- 1-1-2018: Erste Evaluierung für den Einsatz des Wepods auf dem Flughafen in Weeze, Festlegung Routenplan und Ausweitung 2019 und Evaluierung ECOTWIN3 use case
- 1-7-2018 : Neues Fahrzeug befährt die grenzüberschreitender Demo-Route
- 1-1-2019: Neues Fahrzeug liegt nach Entwicklungsphase vor (incl. Ticket-System und MAAS App).
- -----→
- **1-1-2018: First evaluation for the use of the Wepod at the airport in Weeze, determination of route plan and extension 2019 and evaluation ECOTWIN3 use case**
- **1-7-2018: New vehicle drives the cross-border demo route Aachen-Vaals as part of Public Transport Service by ASEAG**
- **1-1-2019: New vehicle is available after development phase (including ticket system and MAAS app).**

## Lessons Learned

---

- **LEGAL:** DE and NL approval processes for CAV are not the same. Vehicle versus situation safety perspective. RDW and TuV do not have the same position in the process. Findings/approval documents or brand specific info is not shared.
- **TECHNICAL:** It is an emerging market. Integrating CAV Architecture in PT-Info and managementsystems is needed.
- **IMPACT:** Assessment of infra still needed and routes need to be fixed and planned to drive shuttles. HD maps are produced over and over in very pilot.
- **DEPLOYMENT:** Platooning technology still waiting for deployment and business cases, Cooperation with companies, government and knowledge institutes is needed, so is a learning by doing approach; but in practice this is quite new to all stakeholders.
- **HUMAN FACTORS:** Local involvement and trust building requires an on-going attention. Aiming for level 4 is hard but better than the incremental approach.

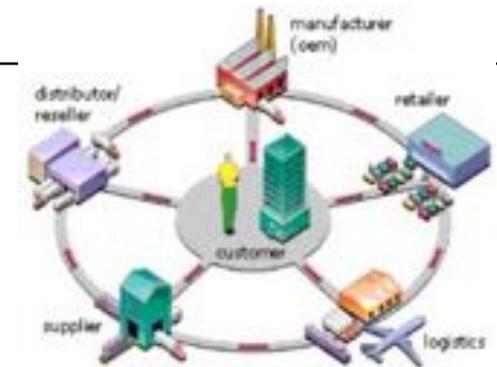




# Was haben wir 2020 erreicht?

## AP 2 Platooning-Trucks: Besserer Transport zw. NRW und NL

- Günstigere, umweltfreundlichere, schneller und flexiblere Transportmethode
- Testbetrieb: Autonom fahrende Lkw's im Konvooi (Blumen/Pflanzen)
- Optimiertere Transportketten, kein Umschlag
- Wirkungsanalyse für Straßenverkehrsträger
- Risikoanalyse für Versicherer, Genehmigungsbehörden, Zertifizierungen



# MRDH Fieldlab – AVLM & Researchlab Automated Driving Delft

## CARTRE Workshop micro-FESTA



Arjan van Binsbergen  
Transport & Planning, TU Delft

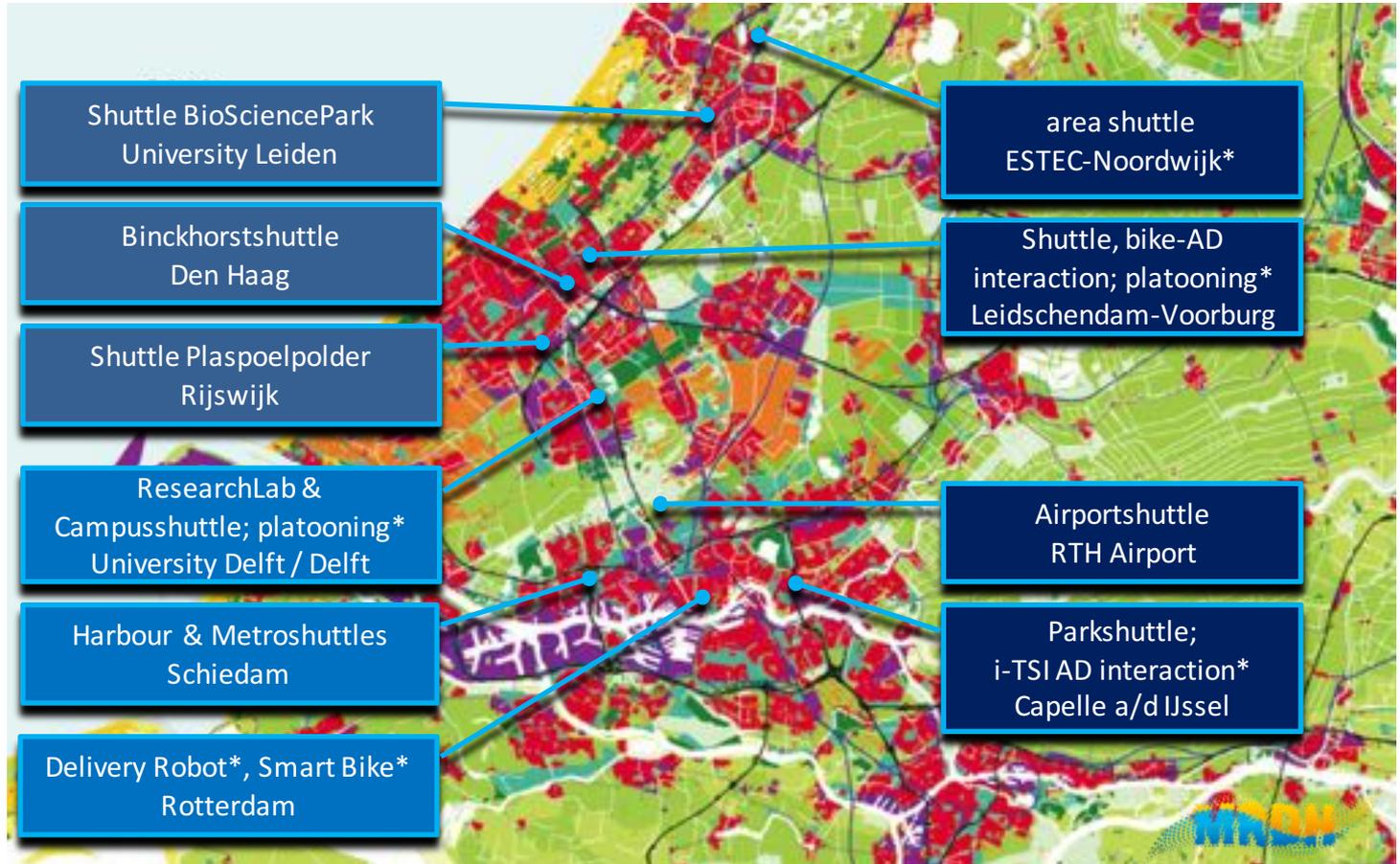
February 21, 2018

# Automated Driving Last Mile (AVLM)

- Automated Driving Last Mile for Public Transport (shuttles, area coverage, on-demand services)
- Joint effort of municipalities & Public Transport Authority (MRDH)
- Aimed at better and more efficient PT
- Coordinated action to compare pilots and tests
- Test facility @RADD

mixed traffic  
no dedicated infra

# Automated Driving Last Mile (AVLM)



# Research themes

- function / functionalities of AVs
- in-vehicle experience by users
- AV – other traffic (pedestrians, bikes, cars) interaction
- AD and traffic system performance
- AD in Public Transport & Freight Transport

# Researchlab Automated Driving Delft



# Researchlab Automated Driving Delft

- Assets

- control room and sensor network
- vehicles
  - W/WL/IV remote controlled vehicles (Prius, Twizy)
  - automated vehicle (WEPod; owned by Gelderland)
  - robot platform (jackall)
- exemptions & permits road and vehicle authorities
- test application and protocols, incl. risk assessment, check by TU Delft ethical committee and science link
- numerous private & knowledge partners (tech. providers, insurance companies, consultancy firms, universities for applied research)



# Experiments & Findings

- Too high expectations on capabilities, functionality, reliability thus deployability of AD-PT in mixed traffic
- High willingness to co-operate from legislative side (RDW, RWS, municipalities)
- Excellent AD performance on dedicated infra, poor performance in light mixed traffic conditions
- Difficult to create a financially sound AD-PT exploitation model



# Learning experiences

- Challenge to...
  - negotiate (justified) regulators' reserves
  - overcome mutual competition of local actors
  - handle (or circumvent) restrictive PT concession regulations
  - discover the true performance of AD's;  
needs a critical look at press and PR publications
- Need for more realistic expectations regarding capabilities of AD in mixed traffic on the short term



# WS micro-FESTA

## Some ongoing projects at RISE Viktoria

2018-02-21 Utrecht

Victor Malmsten Lundgren, MSc.

*Researcher*

**RISE Research Institutes of Sweden**

Division ICT - Viktoria

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w: [www.ri.se/viktoria](http://www.ri.se/viktoria) e: victor.malmsten@ri.se

Shared  
Shuttle  
Services



# SCOPE

- 6 weeks Campus shuttle
- 6 months Parking shuttles

Med stöd från:



**STRATEGISKA INNOVATIONS-PROGRAM**



DRIVE SWEDEN

May 2017 – Dec 2018



(Part of The Swedish Government's Innovation Partnership Program)

Partners:

GÖTEBORGS STADS  
PARKERING AB



sunfleet



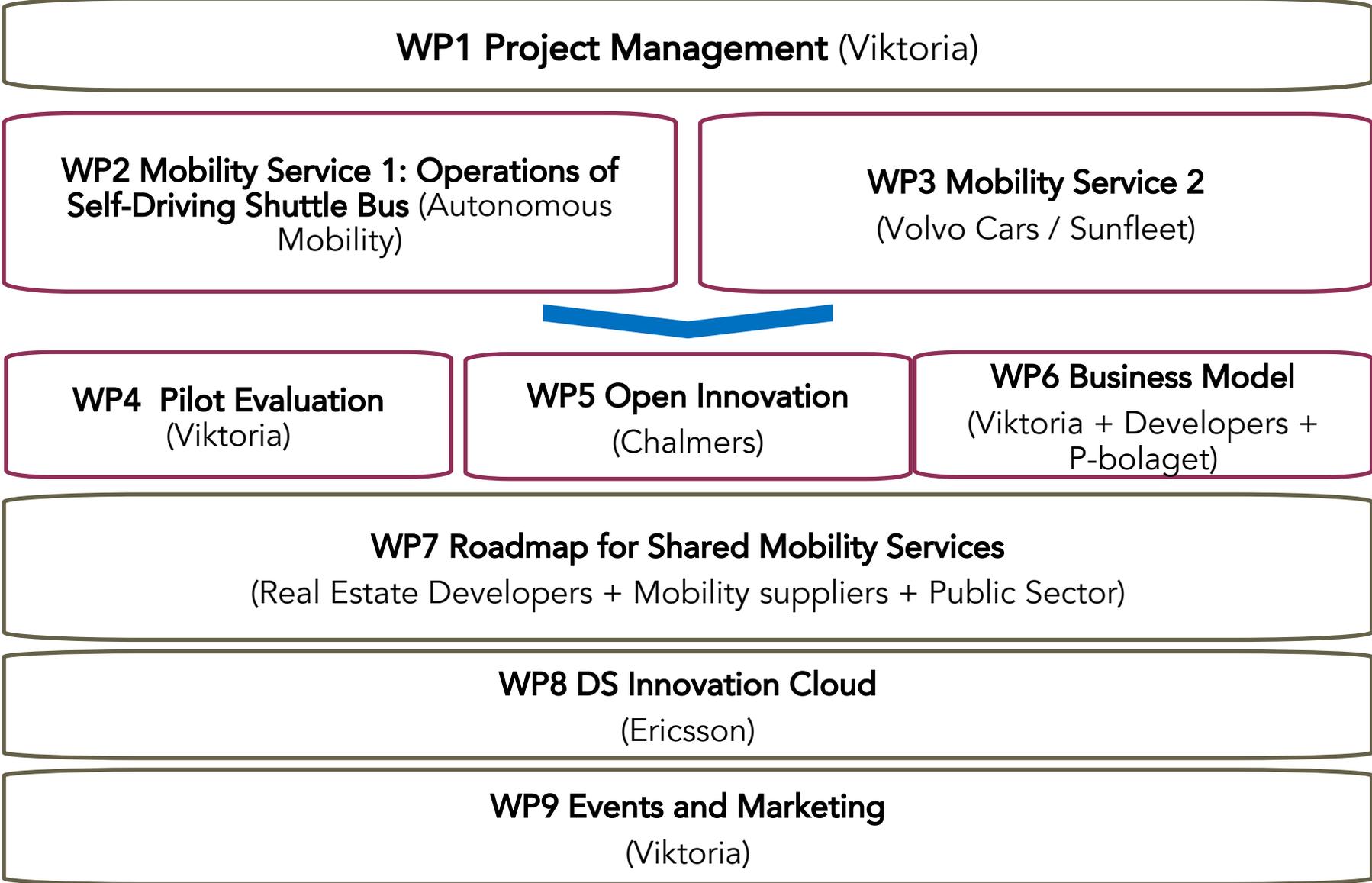
CHALMERS  
UNIVERSITY OF TECHNOLOGY



Framtiden



RI  
SE



# S3 Pilot evaluation

## Scope:

- User acceptance and adoption

## Data collection:

- Questionnaire studies
  - Before use
  - Early use
  - More mature use
- Interview study
- Vehicle and service data

## Outcome:

- Qual. and quant. findings
- Evaluation package for future pilots (micro-FESTA?)





Autonomous  
Base Camp

DRIVE SWEDEN

## Autonomous Base Camp (ABC)

- approx. 20 potential shuttle initiatives around Sweden
  - public and private actors
  - create portfolio of use-cases
    - people
    - logistics
  - sync evaluation methods



# AstaZero experiments

## Scope:

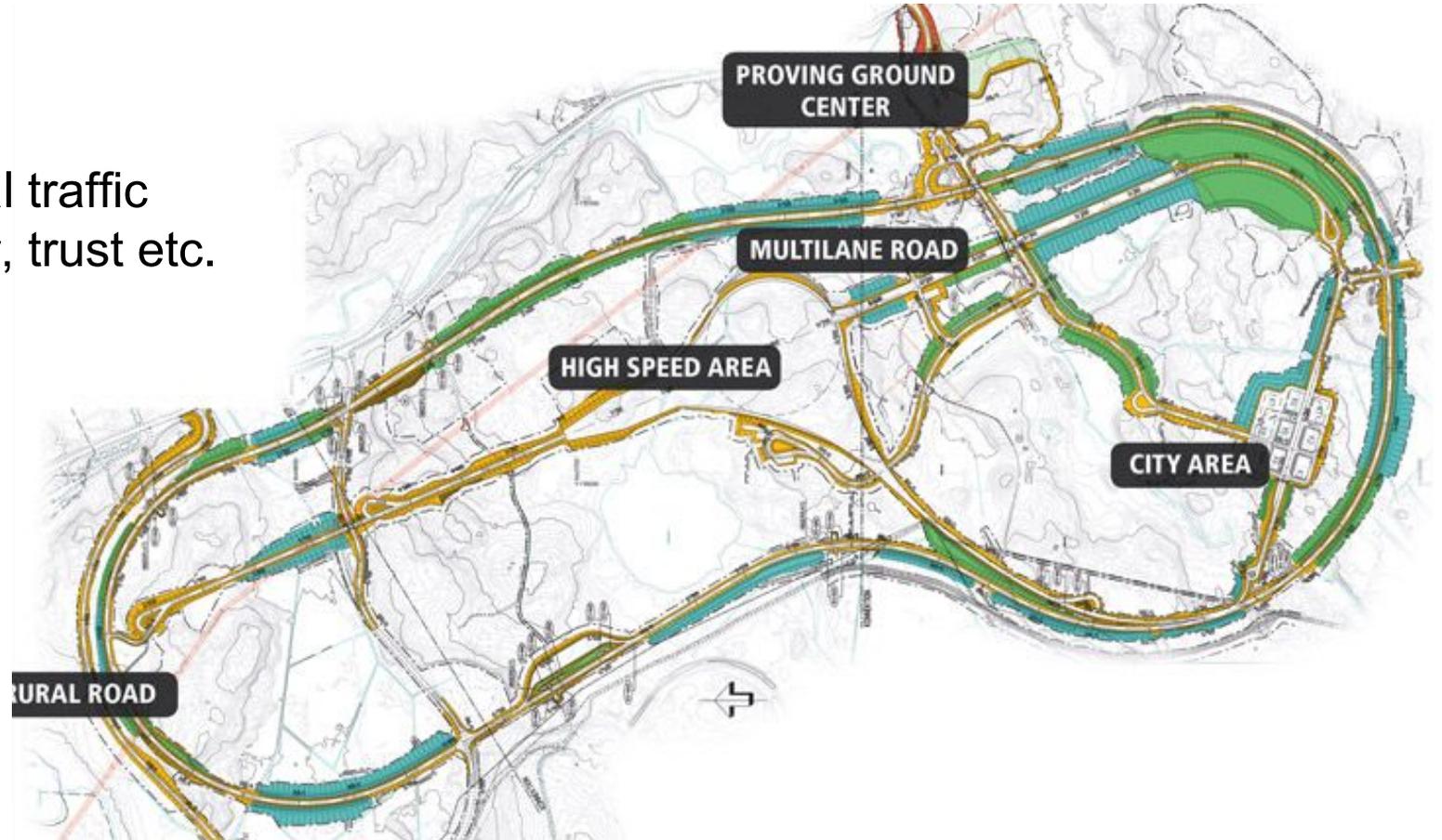
- AstaZero test track to real traffic
- Investigate user behavior, trust etc.

## Data collection:

- Self-assessment
- Vehicle data
- Biometrics
- Eye-tracking

## Outcome:

- Methods for real traffic
- TiC 2018 (Volvo Cars)
- DRAMA (Smart Eye)



21 FEBRUARY 2018

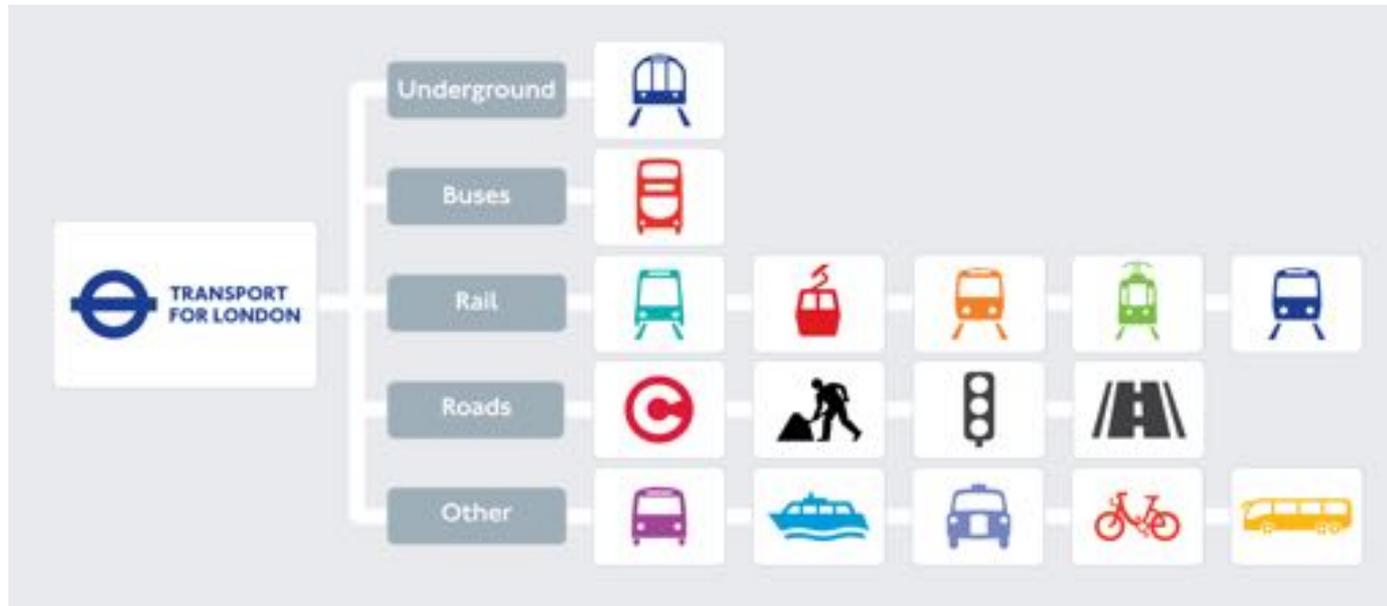
# Connected & Autonomous Vehicles

Gareth Sumner

Foresight Manager: Transport Innovation  
Transport for London



# TfL: our responsibilities...



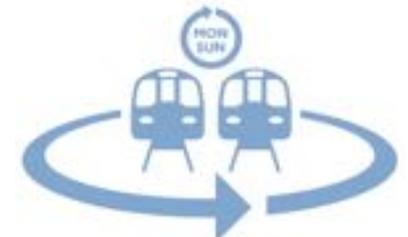
Today the population is 8,600,000 and by 2030 will be around 10,000,000



That's a full car every 26 minutes



Or 2 buses every day



Or 2 Tube trains every week



# Healthy Streets



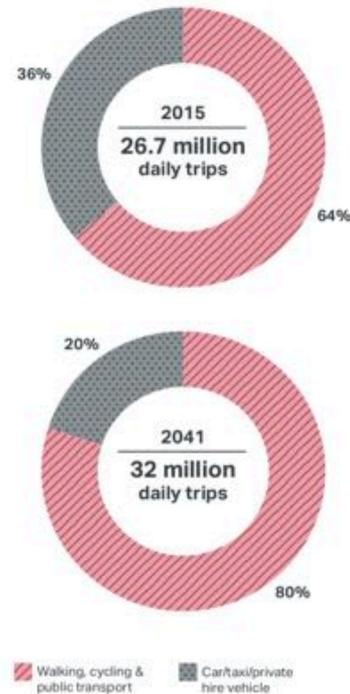
*“If everyone walked or cycled for 20 minutes a day, one in six early deaths among Londoners could be prevented”*



# The Mayor's Transport Strategy



FIGURE 2: MODE SHARE 2015, AND 2041 (EXPECTED)



'The Mayor's aim for 2041 is for 80 per cent of Londoners' trips to be on foot, by cycle or by using public transport.'

## Policy 2

The Mayor, through TfL, the boroughs, police and enforcement authorities, will adopt Vision Zero for road danger in London. The Mayor's aim is for no one to be killed in or by a London bus by 2030, and for all deaths and serious injuries from road collisions to be eliminated from London's streets by 2041.



# CAV priorities for London...

The draft Mayor's Transport Strategy sets out TfL's approach to CAVS.

*“The Mayor, through TfL and working with the DfT and other stakeholders, will adopt an appropriate mix of policy and regulation to ensure connected and autonomous vehicles develop and are used in a way consistent with the policies and proposals of this strategy”*



## Opportunities:

- Complimenting Healthy Streets,
- Reducing emissions,
- Improved access to mobility
- Better road space efficiency

## Risks:

- Increased congestion,
- Poorer air quality and
- Less active travel.
- Mode shift towards private cars

We need to understand the prospective operational challenges, and threats to TfL services in order to develop workable policies.



## We are drawing on a range of studies/trials...

TfL are drawing on a range of studies/trials to maximise learning:

- academic studies;
- industry led feasibility studies; and
- live trials to inform how we develop policy in order to deliver on MTS goals.

LONDON  
HIGHER



# Connectivity is here and growing...

## A2/M2 Trial: Connected Corridor

- This is significant as its focus is on connectivity. This trial will begin in 2018 and will enable us to test enhanced connectivity between vehicles and road infrastructure.
- The trial will showcase the potential of connectivity to improve network management, reduce congestion, communicate better with road users and improve journey reliability & road safety

## A2/M2 Connected Corridor



# TfL are partner to a number of Government funded trials...

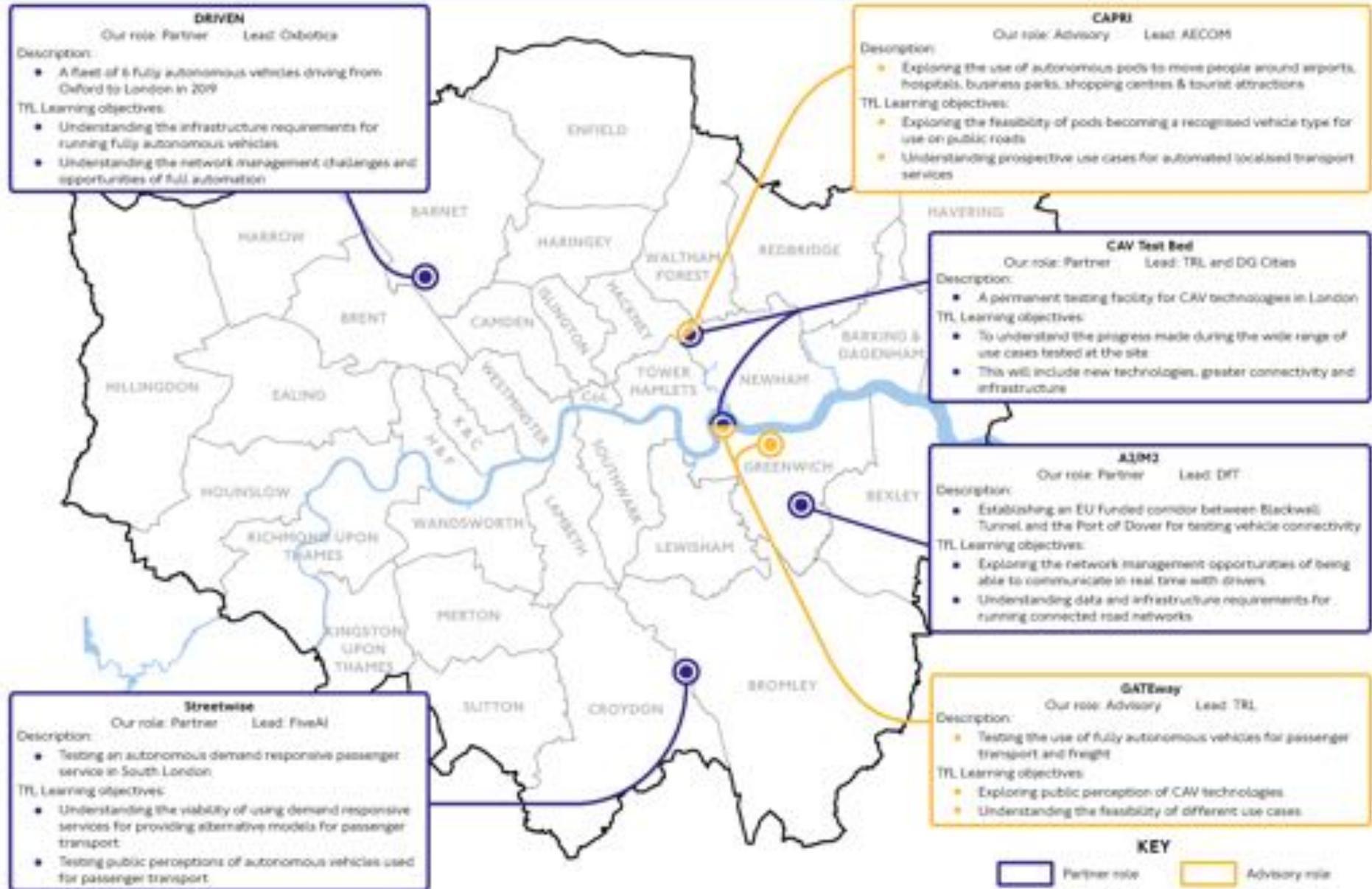
- TfL is directly partnering a number of **Government funded CAV trials**, and are associated with others in an **advisory capacity**.
- **Smart Mobility Living Lab in London**, based in the Royal Borough of Greenwich and nearby Queen Elizabeth Olympic Park in Stratford

Innovate UK

Smart Mobility  
Living Lab™  
London



## Connected and Autonomous Vehicle Trials in London - February 2018



## TfL's priority is safety...

Our priority in all aspects of what TfL does is safety, and this holds true in terms of learning from trials.

However, we also need to understand as much as we can about

- Different use cases,
- Network management opportunities and
- Infrastructure required

... to deliver the benefits



## Future government funded trials..

There is another round of Government funding for trials that is just concluding, and we will be seeking to be a part of more initiatives to continue to **build an evidence base as to how best to harness the benefits of new technologies** in the most complex urban environment in the UK.



Centre for Connected  
& Autonomous Vehicles

Innovate UK



Thank you!  
Gareth Sumner

[garethsumner@tfl.gov.uk](mailto:garethsumner@tfl.gov.uk)



Source: Daimler & Bosch



Source: Royal College of Art





# Test automated shuttle

CARTRE Workshop micro-FESTA

21<sup>st</sup> of February 2018

Utrecht

# Vias insitute

▶ **September 2017:**



▶ **Generate, use and share knowledge regarding:**

- ▶ Road safety
- ▶ Mobility
- ▶ Safety

▶ **Multidisciplinary team of about 120 people:**

- ▶ Psychologists
- ▶ Engineers
- ▶ Geographers
- ▶ ...

▶ **On national level best known for BOB campaigns against drunk driving**

▶ **Wide variety of other activities**

# Vias institute and automated transport

- ▶ Belgian code of practice
- ▶ CARTRE - Coordination of Automated Road Transport Deployment for Europe
- ▶ Questionnaire to identify the expectations of the Belgian population regarding automated road transport
- ▶ Provide information on automated driving
- ▶ Testing of an automated shuttle

# Key features project

- ▶ Rent of an automated shuttle
- ▶ EasyMile
- ▶ Testing on private circuit
- ▶ August 2017 – October 2017
- ▶ Goal
  - ▶ Test interaction with other road users
  - ▶ Test reaction to obstacles
  - ▶ Determine conditions for optimal functioning
  - ▶ Formulate recommendations on how an autonomous shuttle can be integrated on semi-public sites and in every day traffic



*Vias Institute, 2017*

# Key features shuttle

- ▶ First/Last mile
- ▶ 10 to 12 passengers
- ▶ Electric
- ▶ Supervisor required
- ▶ Wheel chair ramp
- ▶ Preprogrammed, fixed trajectory
- ▶ Two driving modes
- ▶ Localisation technology
- ▶ Obstacle detection technology



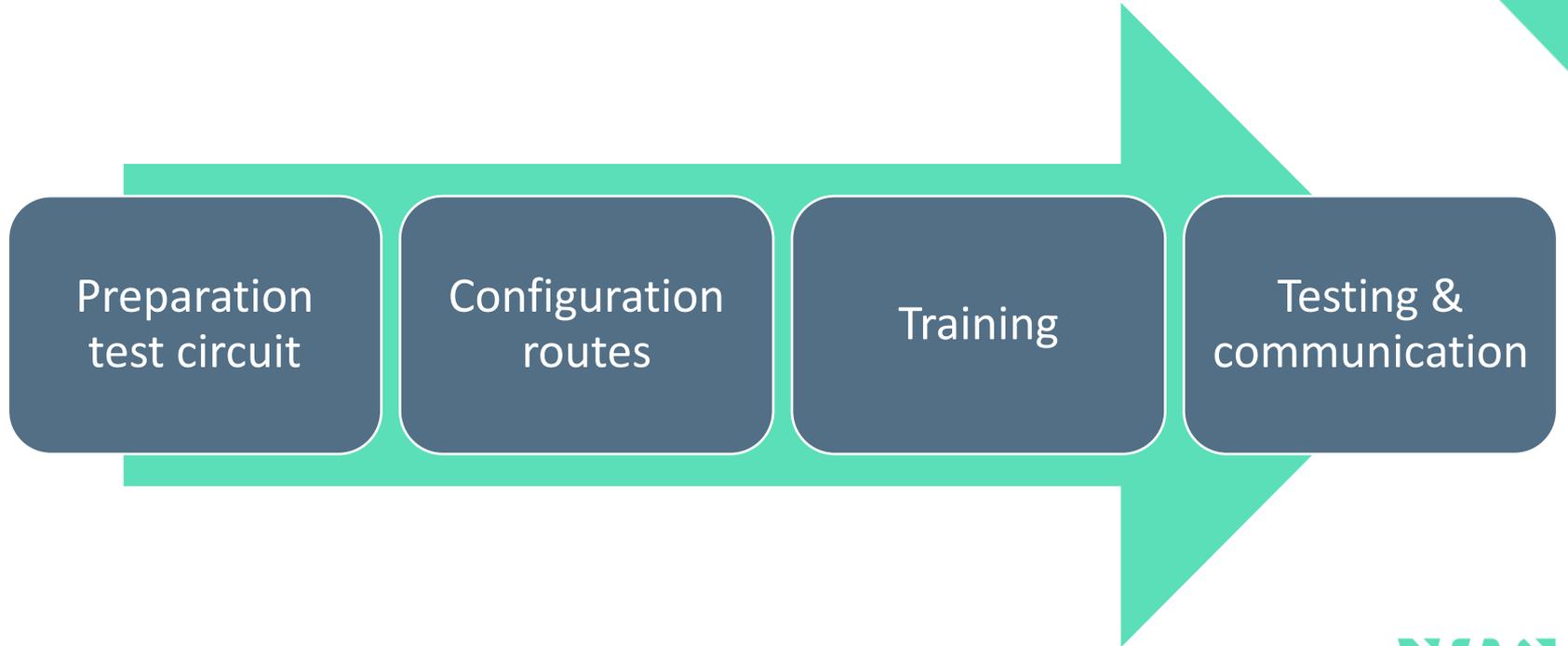
*Vias Institute, 2017*

# Video



*Vias Institute, 2017*

# The project



# The project: preparation test circuit

- ▶ **Localisation:**
  - ▶ Combination of 4 technologies amongst which LIDAR
- ▶ **LIDAR**
  - ▶ Map trajectory
  - ▶ Scan environment
  - ▶ Landmarks
- ▶ **Add landmarks to the test circuit**



Preparation test  
circuit

Configuration  
routes

Training

Testing &  
Communication

# The project: Configuration routes

- ▶ Preprogrammed routes
- ▶ Configuration by EasyMile
- ▶ **Configuration:**
  - ▶ Trajectory
  - ▶ Speed
  - ▶ Stops



# The project: Training

- ▶ **Training manual mode**
- ▶ **Training autonomous mode**
- ▶ **Training support**



# The project: Testing & communication

## TESTING

- ▶ **Develop test scenarios**
  - ▶ Interaction with other road users
  - ▶ Reaction on obstacles
- ▶ **Execute test scenarios**
  - ▶ Observer take notes
  - ▶ Camera inside and camera outside of the shuttle
  - ▶ Photos
- ▶ **Evaluate tests**
  - ▶ Analyse results
  - ▶ Write report

## COMMUNICATION

- ▶ **Press conference**
- ▶ **Visits of interested parties**
- ▶ **Articles in magazines**
- ▶ **Presentations**

Preparation test  
circuit

Configuration  
routes

Training

Testing &  
Communication

# Key conclusions

- ▶ **Infrastructure**

- ▶ LIDAR's used for localisation need sufficient landmarks
- ▶ No interaction with traffic lights, road markings, road signs,...

- ▶ **Limitations of trajectory**

- ▶ Fixed, preprogrammed trajectory
- ▶ Limited speed

- ▶ **Sensitive sensors**

- ▶ **Interaction with other road users and obstacles**

- ▶ Limited possibilities (slow down, stop, emergency stop)
- ▶ Supervisor in shuttle is needed

# Next steps

- ▶ **Execute new tests**
- ▶ **Study passengers in the shuttle and other road users outside the shuttle**
- ▶ **Use attained knowledge to advice third parties working on vehicle automation**
- ▶ **Study the vulnerability of automated vehicles' sensors**



*Federal Public Service  
Mobility and Transport*

This project was performed with the support of the Belgian Federal  
Public Service Mobility and Transport

# Sources

- ▶ FPS Mobility and Transport, 2016, Autonomous vehicles - Code of Practice for testing in Belgium, [mobiliteit.belgium.be/sites/default/files/resources/files/code\\_of\\_practice\\_en\\_2016\\_09.pdf](https://mobiliteit.belgium.be/sites/default/files/resources/files/code_of_practice_en_2016_09.pdf) (consulted on 10/26/2017)
- ▶ Connected and automated driving.eu, 2017, Coordination of Automated Road Transport Deployment for Europe, [connectedautomateddriving.eu/about-us/cartre/](https://connectedautomateddriving.eu/about-us/cartre/) (consulted on 10/26/2017)
- ▶ Vias Institute, 2017, Test met een autonome shuttle door Vias institute, <https://www.youtube.com/watch?v=xlgO5-4ZDig> (consulted on 16/2/2018)



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