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D5.1

Organisation of the driving simulator and on-road trial experiments in *i*-DREAMS

Safe Tolerance Zone calculation and interventions for driver-vehicle-environment interactions under challenging conditions

iDREAMS

Project identification

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Glossary and abbreviations

Word / Abbreviation	Description
ADAS	Advanced Driver Assistance Systems
CANbus	Controlled Area Network vehicle bus
DPO	Data Protection Officer
DV	Dependant variable
ECG	Electrocardiogram
FOTs	Field Operational Trials
GDPR	General Data Protection Regulation
GPS	Global Positioning Service
IV	Independent variable
KPIs	Key Performance Indicators
KSS	Karolinska Sleepiness Scale
OBD-II	On Board Diagnostic
OEMs	Original Equipment Manufacturers
ORR	Office of Road and Rail
PCB	Printed Circuit Board
STZ	Safety Tolerance Zone
WP	Work Package

Executive summary

The overall objective of the *i*-DREAMS project is to setup a framework for the definition, development, testing and validation of a context-aware safety envelope for driving ('Safety Tolerance Zone'), within a smart Driver, Vehicle & Environment Assessment and Monitoring System (*i*-DREAMS). Taking into account driver background factors and real-time risk indicators associated with the driving performance as well as the driver state and driving task complexity indicators, a continuous real-time assessment will be made to monitor and determine if a driver is within acceptable boundaries of safe operation. Moreover, safety-oriented interventions will be developed to inform or warn the driver in real-time in an effective way as well as on an aggregated level after driving, through an app- and web-based gamified coaching platform (post-trip intervention). The *i*-DREAMS project will feature complex field operational trials (FOTs) across four modes of transport (passenger car, truck, bus and rail) and five countries. FOTs will be preceded by simulator trials to test the *i*-DREAMS platform ensuring the Safety Tolerance Zone (STZ) monitoring technology and model works appropriately.

There are two main purposes of this report. The first is to identify the best practice when planning and implementing FOTs, detailing the steps required by *i*-DREAMS for alignment with these. This will include distinguishing the main lessons learnt from previous large scale FOTs and naturalistic driving studies to ensure *i*-DREAMS takes these recommendations into account. The second is to create a 'roadmap' for the successful implementation of the FOTs and simulator trials. This includes expanding on how project Tasks will build on one another to aid in successful implementation of the trials. Current plans for both the simulator trials and FOTs will be outlined, possible legal and ethical issues specific to each trial partner and country of operation will be researched.

Common themes across the FESTA manual and previous FOTs and naturalistic driving studies' lessons learned were: the need for technology to be as concealed and operated with as little user input as possible, to formalise the relationship between the participant and the handling organisation, having sufficient incentivisation to aid recruitment and participant retention, disincentives must be kept to a minimum, such as the inconvenience associated with fitting equipment and downloading data. Two checklists have been developed in this deliverable specifically for the *i*-DREAMS project (Annex 1), adapted from those in FESTA. These will act as important resources throughout the planning and execution of the simulator trials and FOTs to aid in alignment with FESTA guidelines and to ensure no vital steps are omitted by any party involved in either the planning or implementation phases.

Possible barriers to technology implementation and running of the trials were investigated in detail for each trial partner and their corresponding vehicle type with regards to the fitment of the *i*-DREAMS technology platform. There were no major differences identified across the trial partner countries in terms of insurance, legal or ethical considerations when implementing the *i*-DREAMS technology platform for the FOTs and no insurmountable barriers identified from these investigations.

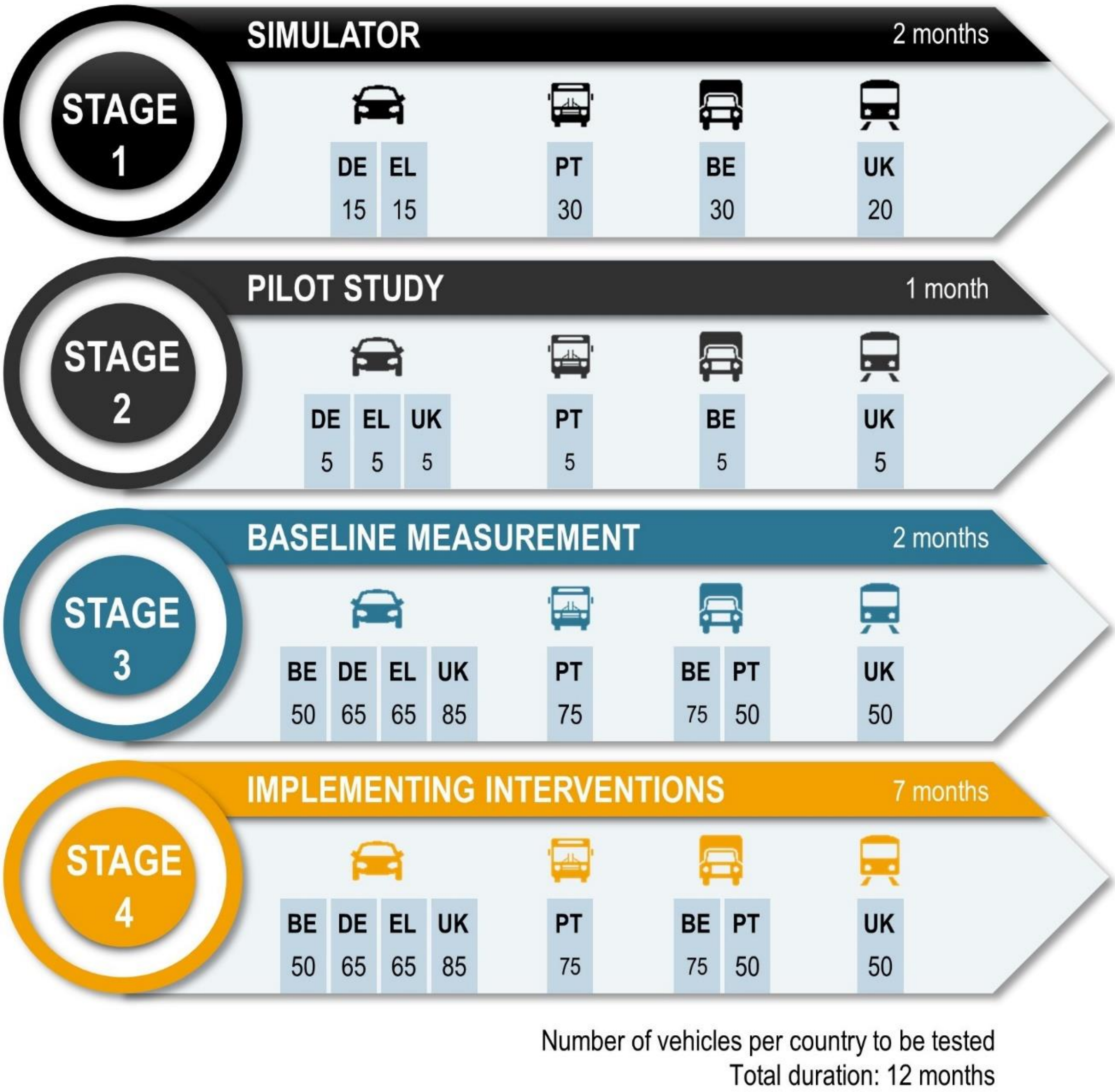


Figure 1 The four stage, five country study design

The study design, depicted in Figure 1, features two separate phases, the simulator trials (Stage 1) and the FOTs (Stages 2,3 and 4). Simulators may, in the first instance, also be used to create data to feed into the STZ mathematical model development, this is not shown in Figure 1 as the need for this stage is dependent on whether real world, legacy data, proves sufficient by itself to feed into the model or not. In Stage 1 simulators will be used to test whether the STZ is observable; ensure the *i*-DREAMS technology platform can detect different phases of the STZ model and gain initial user acceptance/ feedback on the *i*-DREAMS technology. There will be 110 participants in total, for cars there will be 15 in Germany and 15 in Greece, 30 trucks in Belgium, 30 Buses in Portugal and 20 for rail (a mixture of train and tram) in the UK. These simulator trials will take place across a two-month period.

The FOT pilot study (Stage 2) will start after all simulator studies have taken place, these will aid in identify timescales of fitting the technology, issues with equipment use and the data processing methodology. Users who take part in the pilot will not be eligible to be in the main trial. Fifteen car pilot-tests will take place (each pilot is one participant): 5 in Germany, 5 in

Greece and 5 in the UK. Five truck pilot tests will be run in Belgium, 5 Bus pilots will take place in Portugal and 5 rail pilots in the UK. These will all occur across a one-month period,

In the main FOT as there is a limited budget, and therefore finite amount of equipment, the trials will be separated into two groups run back-to-back with a changeover period for the equipment, as opposed to all running in parallel, thus using resources more effectively. The main FOT is composed of a baseline period to collect data with no *i*-DREAMS platform in operation for comparison to when it is (Stage 3), this will run across a 2 month period with each participant experiencing a duration of 4 weeks of data collection. This is followed by an interventions period (Stage 4) which runs across a 7-month period in total. Stage 4 is broken down into 3 separate phases where each phase adds to the level of intervention over the last i.e. the level of equipment and intervention increases, and no equipment is turned off or removed from one phase to another. The phases in Stage 4 are: The in-vehicle intervention phase (4-week duration), the post-trip feedback on smartphone phase (4-week duration) and post-trip feedback on smartphone and gamified web platform (6-week duration).

All 515 participants in Stage 3 (baseline) will be carried over into Stage 4 (intervention) and each will experience every phase in Stage 4. The number of participants will include a total of 265 cars (50 in Belgium, 65 in Germany, 65 in Greece and 85 in the UK). 75 buses (all in Portugal), 125 trucks (75 in Belgium, 50 in Portugal) and 50 rail drivers (all in the UK).

Next crucial steps include finalising the technology being used in the *i*-DREAMS platform to define, develop, test and validate the concept of a context-aware ‘Safety Tolerance Zone’ for driving. Further development of the communication plan including outlining precise procedures for communicating internally in terms of shared learning and flagging of technical issues, and externally, with participants, in both routine and adverse event conditions.

1 Introduction

1.1 About the project

The overall objective of the *i*-DREAMS project is to setup a framework for the definition, development, testing and validation of a context-aware safety envelope for driving (‘Safety Tolerance Zone’), within a smart Driver, Vehicle & Environment Assessment and Monitoring System (*i*-DREAMS). Taking into account driver background factors and real-time risk indicators associated with the driving performance as well as the driver state and driving task complexity indicators, a continuous real-time assessment will be made to monitor and determine if a driver is within acceptable boundaries of safe operation. Moreover, safety-oriented interventions will be developed to inform or warn the driver real-time in an effective way as well as on an aggregated level after driving through an app- and web-based gamified coaching platform. Figure 2 summarises the conceptual framework, which will be tested in a simulator study and three stages of on-road trials in Belgium, Germany, Greece, Portugal and the United Kingdom with a total of 600 participants representing car driver, bus driver, truck drivers and rail drivers.

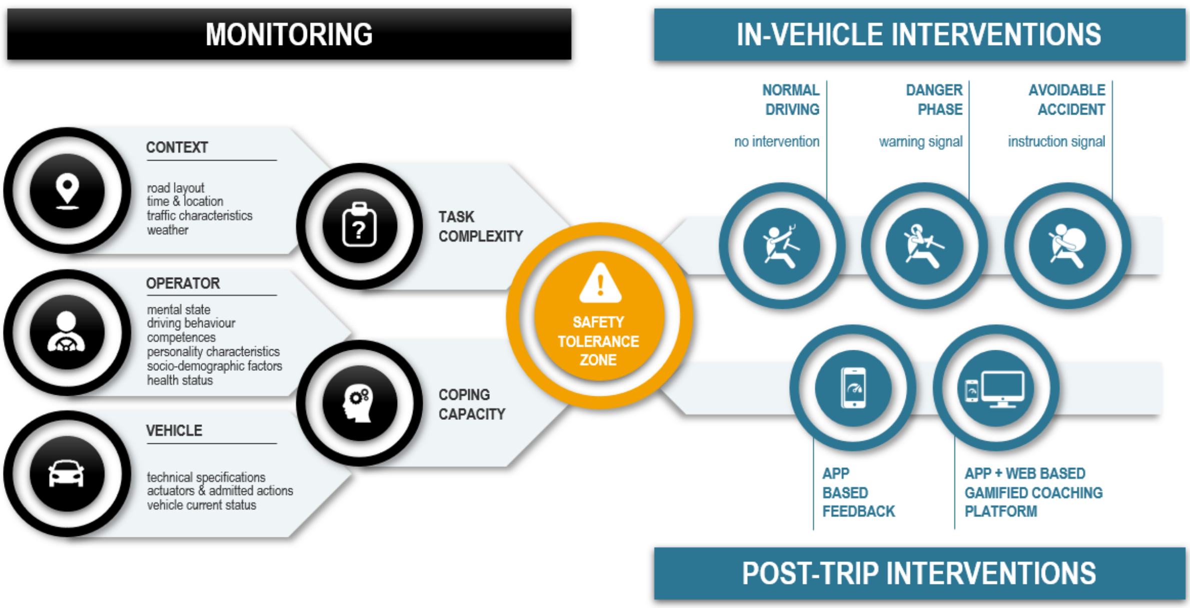


Figure 2: Conceptual framework of the i-DREAMS *platform.*

The key output of the project will be an integrated set of monitoring and communication tools for intervention and support, including e.g. in-vehicle assistance and feedback and notification tools as well as a gamified platform for self-determined goal setting working with incentive schemes, training and community building tools. Examples of the technology which are likely to be implemented include a context aware road monitoring system (Mobileye), OBD-II data logger (or other telematics unit if available in the vehicle), dash camera and electrocardiogram (ECG) or photoplethysmography (PPG) technology (CardioWheel/ Wristband), all except the CardioWheel/ Wristband will be commercially available off the shelf products.

1.2 Deliverable overview and report structure

The *i*-DREAMS project will use field operational trials (FOTs) to test out the concept of a Safety Tolerance Zone (STZ) and trial the *i*-DREAMS platform. The main advantage of a FOT is the potential insight it can offer into system performance in a naturalistic setting. This high level of ecological validity is essential for testing new systems and concepts for application in the real world but large scale FOTs have many challenges. The largest challenge in any FOT is the time, effort and cost associated with running them. For a highly complex FOT to operate smoothly, especially one the scale of *i*-DREAMS (4 different transport types across 5 different countries) a significant amount of forethought and planning is required. This deliverable represents the foundation of those plans.

The main aim of this deliverable is to develop a 'roadmap', identifying what the trials aim to achieve, the steps needed to get there and to start detailing the work towards these goals that has already started.

Sections 2-4 outline the challenges in the planning and methodology that must be overcome in terms of FOT complexities, the aims that need to be achieved and the scale of *i*-DREAMS ambitions in its research design. Section 2 firstly details how *i*-DREAMS will learn from previous EU FOTs through alignment with recommendations published on achieving successful FOTs (FESTA Handbook, 2018). This led to the creation of *i*-DREAMS specific checklists (Annex 1) to help direct all teams involved in the planning and execution of the trials to meet the recommendations laid out in the FESTA Handbook. Section 3 helps to break down and give a direction for the 'roadmap' and planning by giving an overview of the aims, hypothesis and key performance indicators (KPIs) of work packages directly associated with the trials or the models behind the STZ. Section 4 highlights the scope and ambition of the design of the *i*-DREAMS trials.

Sections 5-8 details the work already conducted for planning the trials. The simulator planning is detailed in Section 5 and on-road trials in Section 6. Information on the legal, ethical and insurance issues which might pose challenges is presented in Section 7. An outline for requirements for the communication plan, to help ensure effective discussions and learning, is outlined in Section 8.

2 Developing the *i*-DREAMS protocol

The *i*-DREAMS Project is planning its testing in line with the field operational test support action (FESTA) principles. The FESTA Handbook (2018) offers comprehensive guidance, in the form of a formalised and practical framework, for successfully carrying out field operational trials (FOTs) and was created through a joint effort between research institutes, original equipment manufacturers (OEMs) and other stakeholders. The main aim of this handbook was to create a common methodology for FOTs across Europe. This deliverable will detail current plans for the preparations stage of the *i*-DREAMS FOTs and simulator trials and for this reason will follow the steps in the left-hand side 'preparation' section of Figure 3 to ensure all relevant issues have been considered and addressed. Issues further down the 'V' in **Error! Reference source not found.** require more detailed planning than those listed t the top. This document is delivered at an early stage of the iterative process so some of these plans may need amending once closer to the trials. As part of this section a checklist will be created in-line with the FESTA Handbook to enable project partners to have a quick and efficient means to ensure the FOTs are following the FESTA guidelines. This checklist, which has been tailored specifically for the *i*-DREAMS project, can be found in Annex 1 and its creation is detailed more in Section 2.7.

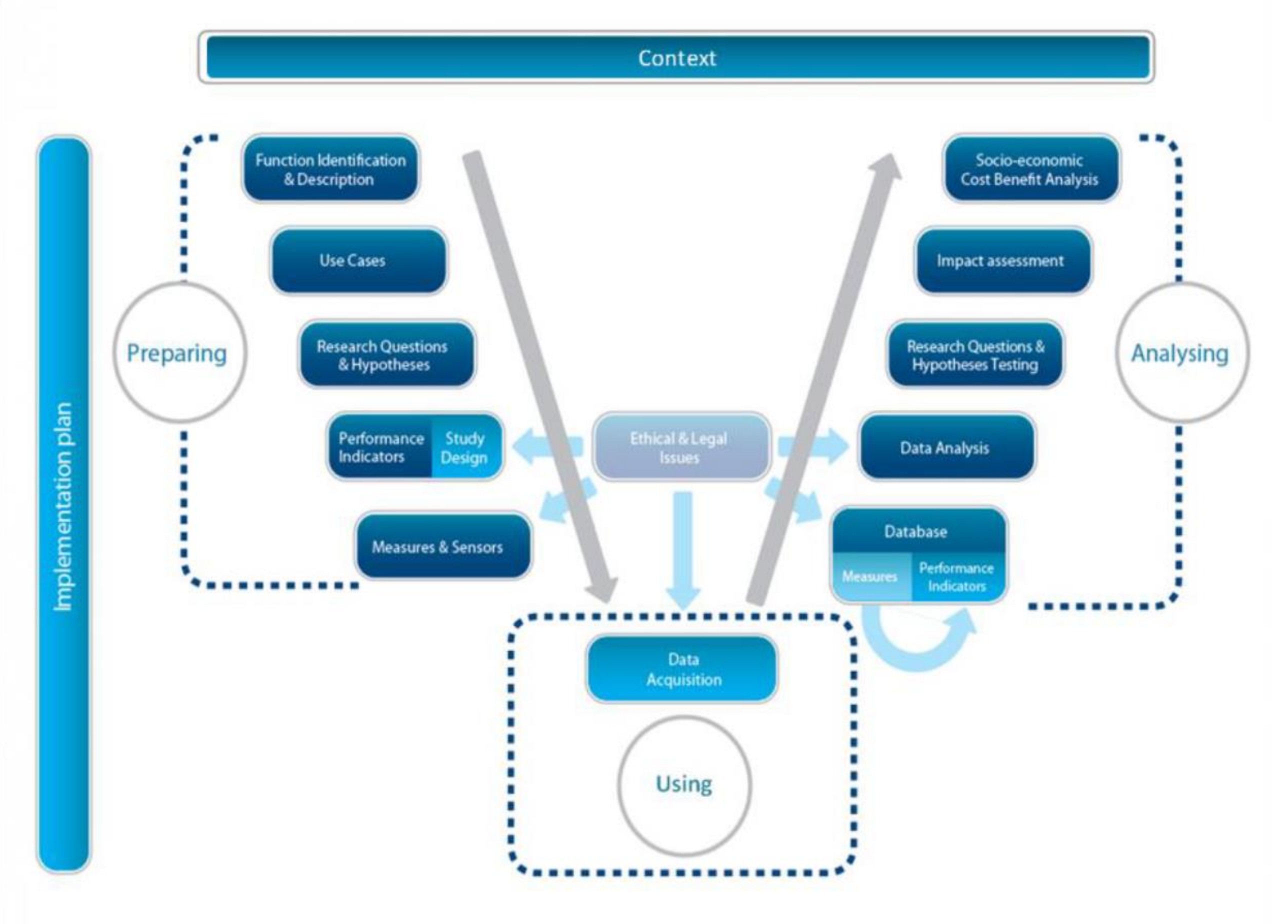


Figure 3: FOT steps that require considering (image reproduced from FESTA Handbook Version 7, page 15)

An FOT is defined as: "*a study undertaken to evaluate a function, or functions, under normal operating conditions in road traffic environments typically encountered by the participants using study design so as to identify real-world effects and benefits*." (FESTA Handbook, 2018, page 14).

Some key points from FESTA when planning the protocol include:

- Baseline measures are essential for comparing the intervention against.
- Planning does not have to be linear, as decisions are made on equipment choices etc. research questions may need to be altered and vice versa.
- Data loggers must run automatically on vehicle switch-on so participants are not reminded of the trials and thus drive as they normally would.

2.1 Legal and ethical issues

FESTA recommends legal and ethical considerations to occur in parallel to the whole project (and afterwards from a data protection perspective), from project agreement through to project completion. Things to consider for the trial include:

- The participant has adequately insurance to be driving their vehicle especially when modifications have occurred due to the FOT.
- A participant agreement is drawn up to formalise the relationship between the participant and the handling organisation. Details on this could include: obligations, liabilities, insurance issues, information on the logging of personal data requiring informed consent, which parties will use the data, data sharing after the project including the use of personal data. The requirements and wording of this may need to be considered for each nation and involve legal consultation.
- What happens in the event of a crash in terms of liability/ excess payment, speeding and parking tickets, responsibility in the event of vehicle damage, who is allowed to drive e.g. other household members?
- What happens to the data once the study finishes and who can access it?
- Privacy issues related to camera use (privacy, the recognisability of other road users and their registration numbers)

These issues will be addressed: In Section 7 of this report in the first instance.

2.2 Function identification and description

FESTA recommends, once equipment has been chosen, that a table should be created with the first column showing the functional classification- a short, high level description of the main functions. The second column should outline the limitations and the circumstances under which it will or will not function (boundary conditions) such as infrastructure and driver demographic requirements. This gives the project a clear definition of the technologies in use and the known parameters under which it is designed to operate, ensuring all partners have the same understanding about the technology in use. As the technologies have not been finalised yet the table cannot be fully completed but for those that are known Table 1 details the functional classifications and limitations and informs Task 5.1 of what should be completed once technology decisions are more mature.

*Table 1 Functional classification and limitations for the currently know i-*DREAMS *technologies*

Functional Classification	Limitations
CardioWheel (CW) – acquire and monitor ECG and steering wheel angle. Information related with identity and fatigue/drowsiness.	If the driver does not use the steering wheel the ECG will not be acquired. The same happens if the driver uses only one hand. The time required for acquiring HRV typical features is long (minimum 2 minutes), so a challenge for having both hands on the wheel. If the driver has cardiovascular problems (or pacemaker) the extracted features may not be meaningful.
Wristband – acquire and monitors PPG. Information related with fatigue/drowsiness.	If the driver is moving the hand were the wrisband is present motion artifacts will induce error in HRV features. If the driver has cardiovascular problems (or pacemaker) the extracted features may not be meaningful. This device is powered by battery, so we will require user cooperation for charging it. The battery estimated power enables the acquisition during 1 week period, so the recharging time could be done during the weekend.
OBD2 logger – acquires vehicle diagnosis information, together with rpm, engine load, and fuel consumption	Sometimes the OBD2 data is missing on some vehicles, or manufactures use different codes (from the standard ones)
Mobileye colision avoidance system – monitors the road ahead of the vehicle, and gives information related with TTC (time to colision), lane departure, and speeding	The system works mainly in daylight conditions. In roads/infrastructures with bad conditions (or low visibility) the system does not produce all the alerts.
CW battery version	CW should be powered using the slipring of the vehicle, but for convinience battery versions will be supplied to some of the scenarios. In this case the devices should be recharged from time to time (period to be confirmed). The system will be provided with a wire plug that should be connected to a vehicle power outlet (to be installed) that will allow this rechargement. This action is to be conducted by the user, and there is the possibiblity of non-cooperation.

Some key points from FESTA relating to functional identification and description include:

- Technology must be chosen which best meets the research questions- this information should come from stakeholders, such as through surveys and focus groups and results from literature searches in other work packages.
- Careful consideration of the technologies and how they are fitted is needed to ensure they do not affect crash worthiness or normal vehicle operation.

These will be addressed in:

D3.2 Toolbox of evidence based recommended data collection tools and monitoring methods

D3.4 Experimental protocol (description of the general parameters and environment for testing)

D3.6 Enhanced toolbox of recommended data collection tools, monitoring methods and interventions

D4.1 A set of flexible modules for sensor data collection, integration and real-time processing

D5.2 Description of the driving simulator experiment

D5.3 Description of the on-road driving trials

2.3 Use cases

Use cases describe the boundary conditions under which functions are intended to be analysed. They are covered from three viewpoints:

1. Platform and vehicle specification
2. Environmental conditions specification
3. Driver characteristics and status specification

The broad use cases for the project will be defined in Deliverable 3.1 and the more specific scenarios developed in Deliverable 3.4.

It is essential to have very tight definitions of when the technology will be in use (i.e. what scenarios it can and cannot be of assistance in) during the FOT and the circumstances that warrant analysing in terms of performance.

These will be addressed in:

D3.4 Experimental protocol

D5.2 Description of the driving simulator experiment

D5.3 Description of the on-road driving trials

D6.1 Analysis of task complexity factors

D6.2 Analysis of coping capacity factors: vehicle and operator state

D7.1 Methodology for the evaluation of interventions

D7.2 Effectiveness evaluation of the interventions

2.4 Research questions and hypothesis

To be compliant with FESTA guidelines it will be important to have a top-down and bottom-up approach to hypothesis formulation, jointly developed by a multi-disciplinary team using the KPIs (e.g. time to collision) to test them. Examples of how this can work in practice for an FOT can be found in Franzén et al. (2012). *i*-DREAMS must consider the trade-off between few in-depth research questions versus many questions covered in less depth and choose appropriately.

These will be addressed in:

D3.4 Experimental protocol

D5.2 Description of the driving simulator experiment

D5.3 Description of the on-road driving trials

2.5 Key performance indicators

Crashes are multi-causational so key performance indicators should take into account exposure, crash risk and injury risk (linked to strategic, tactical and operational decisions).

FESTA gives recommendations to the categories of KPIs that should be considered, the safety-related measures appropriate to *i*-DREAMS are:

- **Intrinsic performance**- does the platform perform as expected, indicating false alarms, misses and the contexts in which it didn't perform well.
- **Modes of drivers' interaction with the platform-** examines how drivers used the platform and how this may have affected driving behaviour and performance.
- **Acceptance and trust-** the degree of approval by the users.
- **Perceived platform consequence-** positive or negative perceived consequences of use of the platform.
- **Motivation-** the level of motivation/impetus to use the platform- linked to behavioural intention (level of intention to use the platform) which can be collected prior to testing for comparison.
- **Usability-** qualitative feedback on the users' perception of usability of the platform, this includes interface designs, interactions, fitting and maintenance.

These will be addressed in:

D3.1 Framework for operational design of experimental work in *i*-DREAMS

D3.2 Toolbox of recommended data collection tools and monitoring methods

D3.3 Toolbox of recommended interventions to assist drivers in maintaining STZ

D3.4 Experimental protocol

D5.2 Description of the driving simulator experiment

D5.3 Description of the on-road driving trials

2.6 Study design

Being able to conclude with some confidence that the DV is a result of the IV will always be difficult in a FOT, the lack of control as a result of having the technical equipment in real cars, on real roads with drivers performing everyday driving duties limits this. For this reason considering confounding factors that can be controlled is particularly important when designing the study- these include: history, maturation, testing, selection, drop-out and experimenter bias.

These will be addressed in:

D3.4 Experimental protocol

D5.2 Description of the driving simulator experiment

D5.3 Description of the on-road driving trials

2.7 *i*-DREAMS checklist development

The checklists (Annex 1) are modifications of the eighteen FESTA checklists which detail the planning and implementation stages of a FOT, these can be found in the appendices of the FESTA Handbook, tailoring them specifically for the *i*-DREAMS project. There are two separate checklists, one for the planning of the trials and a second for the implementation of the trials. This tailoring process required selecting the appropriate actions from the extensive number of FESTA checklists, as well as using the information in the previous sub-sections, to ensure relevant actions were included. By separating the checklists based on planning and implementation it means once planning is complete only actions relevant for the implementation stage need to be consulted when running the trials, helping to remove the 'noise' of the planning actions for the implementation stages. The *i*-DREAMS checklists are an important part of this deliverable, they act as useful reminders of the level of work required to effectively plan and run the large scale FOTs and simulator studies and it is believed they will prove very useful as reference documents to ensure efficient planning and implementation. Some of the actions contained within the checklist are answered within this deliverable but for many they prove as useful reminders for subsequent workpackages and deliverables of tasks yet to be done, thus aiding in this deliverable's aims of creating a roadmap for the experiments.

2.8 Lessons from previous FOT and naturalistic driving studies projects

Most previous large scale FOTs and naturalistic driving studies have published the most important lessons they learned from going through this challenging process. This section will highlight the most important of these, which *i*-DREAMS will need to consider.

The U-Drive project (http://www.udrive.eu/), was a naturalistic driving study, as opposed to a FOT, but it shared many similarities and used the FESTA guidelines in the planning stages. They documented some lessons to take note of in their Deliverable 35.1.

- National data protection agencies may get involved and lead to delays (especially when dealing with images and personal data), anticipate this and be in consultation with them from the outset.
- Selecting one or two vehicle types made equipping the cars easier but recruitment more difficult, especially if the vehicles were less prevalent in some countries than others. This trade-off should be carefully considered when developing the recruitment strategy.
- Participant drop-out was a big issue and should be accounted for by over-recruiting and having a back-up list of participants where possible.
- Questionnaire data revealed that hiding of the equipment to the furthest extent possible is preferable to help participants feel comfortable and behave more naturally.

- Using external suppliers and technicians gives an opportunity for misunderstandings, and ambiguities, leading to delays and conflicts. Every effort from the outset should be made to be clear on the roles, responsibilities, timelines and liabilities of these third parties.
- Detailed and realistic plans of action at as early a stage as possible are important to avoid delays, resource issues and overspending.

The Prologue project (https://prologue.kfv.at/) was also a naturalistic driving study and in their deliverable 4.1 they detailed lessons learned from the running of it. Many were similar to those in U-Drive but they also suggested:

- Supplementing automatic recording of behaviour with interviews and resources such as the Driver Behaviour Questionnaire, sensation seeking scales, past violations and crash history etc. to enrich findings.
- Recruiting drivers is a long and difficult process. Financial benefits to participants should be considered where possible. An opportunity to give drivers a summary of their data at the end of the study may prove attractive to some.
- The absence of disincentives should be prioritised also, such as the equipment interfering in normal daily functioning, inconvenience of fitting equipment and downloading data kept to a minimum.
- A way of reliably identifying the driver or ensuring all possible drivers of a vehicle have consented to being in the study is important for data protection reasons when shared vehicles are involved.

The EuroFOT project (https://www.eurofot-ip.eu/) was a Europe wide FOT which aimed to demonstrate how driver assistance systems could increase safety and fuel efficiency. In their Deliverable 11.3 they had a number of lessons learned, again many are similar to suggestions in FESTA and the above studies but also highlight:

- It might be necessary to change the sampling strategy if struggling to recruit including the age of intended drivers and the desired annual mileage.
- Females in particular proved difficult to recruit, this was especially true among the truck driver sample. It may be difficult to get a representative sample so expect extra effort to be required to attain this. It is important not to compromise on this, the temptation is to have more vehicles testing at the expense of effort spent recruiting. Such a homogenous sample then becomes more of a demonstration than a research project. The right sample should prevail over attaining promised numbers.
- It may prove harder than expected to turn all technology off in the baseline period, this is especially true when technology is built into participants' vehicles and they do not wish for it to be turned off. There may have to be some compromise in the experimental design once it is under way to find a working approach around this.
- If you turn systems off it may be difficult to ensure the participant has not just turned them back on, ways of preventing this are difficult and ways of monitoring it are often not easy either so this needs to be considered in the planning and analysis phase.
- If the incentives are not sufficiently appealing (e.g. a full suite of technology to keep after the study or money for participation) then expect to have less control over participant behaviour and a higher drop-out rate as they have less incentive to comply with project wishes.

- Participants may have fears about their warranties becoming void due to installed equipment, definitively ensure this will not be the case, and if true then reassure them appropriately.
- If the vehicle is filming then a policy in the event of recording in restricted areas such as military bases and company yards needs to be created.
- Don't underestimate the amount of incentive required to get participants, it will need to be very rewarding.
- If money is given for taking part then it will be necessary to identify the correct taxation procedure for each country taking part, this is likely to be a bigger than job than you anticipate.
- During the FOT a hotline proved to be essential so participants always had someone knowledgeable about hardware or software issues to be in touch with as soon as they needed it. An effective liaison procedure should be set-up to account for this.
- To be able to assume to some degree that any changes in behaviour are a result of the technology and not some other factor there needs to be a strong literature base to suggest this, for other less investigated technology this up-scaling of assumptions proves extremely difficult.
- Data sharing across sites needs to be discussed and well understood before the trials start so it is clear what is to be shared and what is confidential.
- It may be necessary to heavily revise the intended trials after the piloting phase. This should therefore be a sufficient length to practice many, if not all, of your protocols. Communication protocols and feedback on information given at the recruitment, technology familiarisation and trial phase are very important to gather to improve user experience and recruitment rate in the main trial.
- A sufficiently long or short period of testing to remove the effects of seasonal changes is necessary, if all baselines are in summer and interventions in winter then this could have a large effect on results.
- A large amount of the withdrawals from the project came after the first questionnaire, ensure questionnaires are as short as possible and spread out across the starting period to prevent participants from being instantly discouraged.

2.9 Summary of Work Package 2 literature findings

Work Package 2 conducted detailed literature searches to investigate current knowledge on measures and possible technology choices for driver state monitoring. Table 2 summarises these findings and will be used in Work Package 5 to help inform technology choice for the simulator trials and FOTs across the vehicle types.

Table 2 Summary of Work Package 2 findings on driver state monitoring technology choice, measures and advantages and disadvantages

Operator state	Optimal measure	Ideal technology	Advantages / disadvantages
Attention and distraction	PERCLOS *Percentage of time eyelid covers 80% or more of the pupil*	Eye tracker (glasses / system) Driver facing camera	+ Passive, continuous, objective measure - Privacy issue of recording individuals
	PERLOOK *Percentage of time spent not looking ahead during a certain time interval*	Eye tracker (glasses / system) Driver facing camera	

	Glance duration	Eye tracker (glasses / system) Driver facing camera	- Head movements/poor lighting may affect accuracy - Eye tracker could interfere with use of prescription glasses - Consideration of analysis from camera
	Head movement	Driver facing camera	
	Driver behaviour (lateral and longitudinal measures, reaction time, gap acceptance)	Forward facing camera and collision avoidance system (Mobileye) Smartphone based technologies Vehicle data	+ Unobtrusive measure + Feedback could be personalised + Commonly used in transport safety research - Weather could affect systems capabilities - Temptation of drivers engaging with smartphones when driving -Privacy issues (GPS)
Alertness (fatigue / sleepiness)	Blink rate	Eye tracker (glasses / system) Driver facing camera	+ Commonly used measure in experimental and commercial sleepiness detection + Passive, continuous, objective measure + Robust indicators of sleepiness - Privacy issue of recording individuals - Head movements/poor lighting may affect accuracy - Eye tracker could interfere with use of prescription glasses - May struggle to detect lower levels of sleepiness
	PERCLOS	Eye tracker (glasses / system) Driver facing camera	
	HRV *Heart rate variability*	Heart rate sensors embedded in steering wheel (CardioWheel) Wearable heart rate monitor	+ Minimally invasive - Heart rate can be influenced by external factors - Sleepy individuals may show different responses in HRV measures - Effective pre-processing algorithms need to be utilised

			- May struggle to detect lower levels of sleepiness
Emotion	ECG (heart rate) *Electrocardiogram*	ECG sensors (CardioWheel)	+ Minimally invasive - Heart rate can be influenced by external factors
	Visual changes	Driver facing camera	+ Passive, continuous, objective measure - Privacy issue of recording individuals - Head movements/poor lighting may affect accuracy - Consideration of analysis (subjective opinion or complex algorithm?)
	EDA *Electrodermal activity*	EDA wearable device Thermal camera	+ Minimally invasive - Privacy issue of recording individuals
Substance impairedness	Blood Alcohol Content / substance detection	Biological samples (breathalyser, blood, saliva, urine)	+ Breathalysers can be portable and self-administered - Time taken to collect and analyse samples - Typically not available to be used in real time - Majority cannot be self-administered - Issues with calibration
	Transdermal measures	Wearable sensors	+ Minimally invasive + Continuous monitoring - Emerging technology
	Tissue readings	Wearable sensors (TruTouch)	+ Minimally invasive + Can be used in real time - Emerging technology
Task demand	Eye fixations	Eye tracker (glasses / system) Driver facing camera	+ Passive, continuous, objective measure - Privacy issue of recording individuals

			- Head movements/poor lighting may affect accuracy - Eye tracker could interfere with use of prescription glasses
	ECG	ECG sensors (CardioWheel)	+ Minimally invasive - Heart rate can be influenced by external factors
	Driving behaviour (lateral position, longitudinal control, speed, reaction time)	Forward facing camera and collision avoidance system (Mobileye) Smartphone based technologies Vehicle data	+ Unobtrusive measure + Feedback could be personalised + Commonly used in transport safety research - Weather could affect systems capabilities - Temptation of drivers engaging with smartphones when driving -Privacy issues (GPS)
Driving behaviour	Speed Braking Lateral and longitudinal movement Trajectory Acceleration Time to collision	Forward facing camera and collision avoidance system (Mobileye) Smartphone based technologies Vehicle data	+ Unobtrusive measure + Feedback could be personalised + Commonly used in transport safety research - Weather could affect systems capabilities - Temptation of drivers engaging with smartphones when driving -Privacy issues (GPS)

Overall recommendations for *i*-DREAMS from Work Package 2 include:

- Using at least two approaches for driver monitoring.
- Consider the application and transferability of measures from on-road vehicles to train and tram.
- Majority of driver mental state variables could be measured with cameras, eye tracking, and heart rate sensors either embedded in the steering wheel or incorporated into wearable technology.
- Thoroughly testing indicators and measures at the simulator stage.
- Algorithms estimating a driver's state may need to be personalised – individual differences.

3 Research questions and hypothesis

The following section details project plans for those Tasks which are relevant to the simulator trials and FOTs and the theoretical models which underpin them. Task aims, objectives, hypothesis (where relevant) and key performance indicators (KPIs) (where relevant) are noted.

3.1 Task 3.1. Development of the framework for operational design

3.1.1 The aims and objectives

Aim:

To develop the underpinning methodological framework on which the practical development, testing and validation will be built upon.

Objectives:

- To describe the driving theories that inform the concept of the STZ
- To describe the theoretical concept of the STZ.
- To consult with experts about how the *i*-DREAMS platform will be useful in each of the trial modes (survey).

3.1.2 The key research questions the task is addressing

From a theoretical perspective what is the definition of the STZ?

What technical considerations need to be taken into account when designing the *i*-DREAMS platform for the different modes?

3.1.3 KPIs:

- Definition of the STZ that can be used by T3.2.
- An analysis of survey results and implications.
- List of considerations per trial transport mode.

3.2 Task 3.2. Toolbox of recommended data collection tools and monitoring methods and conceptual definition of the Safety Tolerance Zone

3.2.1 The aims and objectives

Aims:

To develop a mathematical model of the STZ, taking into account the most appropriate indicators of driver state and task demand.

Objectives:

- Assess and evaluate data collection tools and driver/environment monitoring
- Identify the variables needed to be taken into account for modelling STZ.
- Develop a mathematical model taking into account the input variables which can be calculated in real time. This includes the definition of output variables.
- Test and validate the model with the technologies needed.

- Update and make recommendations on the model based on the experiments.

3.2.2 The key research questions the task is addressing

How can the STZ be mathematically defined and modelled in real-time? Once the STZ has been theoretically defined (in T3.1), it is then mathematically defined in T3.2.

3.2.3 KPIs

Accuracy, validity, real-time efficiency, recall/false alarm ratio.

3.3 Task 3.3. Selection of intervention approaches

3.3.1 The aims and objectives

<u>Aim:</u>

Based on the list of potential interventions, as identified in Task 2.3 (overview of state-of-the-art technology for safety interventions), decide which of these interventions are most suited for the purposes of the *i*-DREAMS project.

Criteria that are considered relevant for the final selection, may include:

- Recommendations of Task 2.3 regarding current literature findings
- Target risk to be addressed per transport mode (defined in Task 3.4) – because interventions should be selected that mitigate the risks that the i-DREAMS project proposes to address.
- Expected effectiveness of the intervention (how effective is the intervention expected to be in reducing the target risk).
- Expected difficulty (cost and time) of implementation / installation.
- Expected acceptability by the user (e.g. intrusiveness).
- How well does the intervention align with the concept of the STZ (e.g. the STZ defines different stages of risk for which different types of interventions can be triggered).
- Potential negative (safety) side effects of the intervention.
- Compliance with existing standards, regulations or best practices.
- Cost of the intervention (in case specific equipment must be purchased).
- Innovation capacity (how innovative is the intervention when compared to existing interventions? – this aspect also relates to the potential exploitation strategy).
- Transferability to other modes.

3.3.2 The key research questions the task is addressing

What is the list of most suitable interventions, both for real-time (in-vehicle) and for post-trip, to be implemented in the driving simulator and in the vehicles (per mode) for the field trials?

3.3.3 KPIs

An evidence-based list of interventions will be selected that will be adopted per transport mode.

3.4 Task 3.4. Design experimental protocol

3.4.1 The aims and objectives

Aim:

To provide the necessary experimental protocol to inform the simulator and on-road trials as well as the analysis of the resulting data.

Objectives:

- To define the general parameters and environment for testing
- To define the high-risk scenarios under which the *i*-DREAMS platform will be tested

3.4.2 The key research questions the task is addressing

What scenarios should be used to test the *i*-DREAMS platform?

What are the most effective experimental protocols for testing the *i*-DREAMS platform for each trial transport mode?

3.4.3 KPIs

Recommendations for general experimental conditions for both simulator and on-road testing for each transport mode.

A toolbox of scenario designs that define the features of high-risk situation for each trial transport mode.

3.5 Task 3.5. The design procedures for big data handling and processing

3.5.1 The aims and objectives

Develop logistics of handling data (cleaning, data coding procedures) to make it useable and transferable.

Develop Standard i-DREAMS procedures to meet the legal and ethical requirements of collecting, handling and storing such data (data formats, standards, and communication protocols).

Develop procedures to align with the FAIR principles (Findable, Accessible, Interoperable, Reusable).

Develop procedures regarding the creation of an Open Source Human Factors database in light of the principle of Open Access to Research Data (H2020 Open Research Data Pilot).

Creation and regular updating of the Data Management Plan (DMP).

3.5.2 The key research questions the task is addressing

How can we best handle data, including personal data, in a legal and ethical way, allowing us still to achieve the project objectives?

3.5.3 KPIs

- Internal approval from Data and Knowledge Management Committee of the project
- Early testing and resolution of issues for data storage

- Creation of a publicly accessible Human Factors database
- Deliverable of a final data management plan

3.6 Task 5.1. Simulator and field study organisation and support

3.6.1 The aims and objectives

Detail what is currently planned for the simulator trials.

Detail what is currently planned for the field-trial exercises.

Create a 'roadmap' of how to progress the trials for successful implementation.

Set-out the contents of a communications protocol for use both internally and external to the project

3.6.2 The key research questions the task is addressing

What is best practice for the planning and running of FOTs and simulator experiments, how will the project meet these and what barriers need to be overcome?

3.6.3 KPIs

- Up-to-date plans for simulator trials (including equipment specification and timelines) are produced.
- Up-to-date plans for on-road trials (including equipment specification and timelines) are produced.
- An i-DREAMS specific checklist is created which considers learning from previous FOTs and best practice guidance.
- Aims, objectives and KPIs established for relevant project tasks to guide direction of the trials.
- Required content of a communications protocol is identified to inform on plans for interactions internally within the project and external to it when trials are underway.

3.7 Task 5.2. Participant recruitment and follow-up

3.7.1 The aims and objectives

To define appropriate inclusion and exclusion criteria for participant selection.

To define a suitable recruitment strategy for each transport mode and each country.

To create a procedure to interact with the partners and to monitor the progress of recruitment in each country where simulator and field trials are taking place.

To create a methodology to monitor the progress of participants throughout the experiments.

To create a methodology to interact with the participants to keep them motivated (this includes a strategy to reward participants who are showing a high level of participation).

To create a procedure to deal with participant dropout.

3.7.2 The key research questions the task is addressing

How to define the strategy to identify and recruit participants?

How to define the most appropriate inclusion and/or exclusion criteria taking into account e.g. gender, age, driving experience, ethnicity?

How to follow up on the progress of recruitment by the different field trial partners?

How to monitor the level of cooperation of participants during the experiments?

How to prevent and deal with participant drop-out when it occurs?

How to reward the participants (during and after their participation)?

3.7.3 KPIs

- Recruitment levels reached per country and per mode.
- Participants' level of participation during the experiments.
- Participant dropout rate.

3.8 Task 5.3. Driving simulator testing

3.8.1 The aims and objectives

Act as a first stage of validating the STZ and allow fine tuning before carrying the model through to the on-road trials.

Trial a number of scenarios and conditions to find the most relevant for testing of the STZ.

Test initial user acceptance of the *i*-DREAMS platform.

3.8.2 The key research questions the task is addressing

How does the i-DREAMS platform perform in a simulated environment?

What changes to the algorithm are needed?

What are the best scenarios and conditions (e.g. road layout, traffic levels, weather etc.) for the on-road trials based on findings from the simulator?

Is the concept of the STZ working in its current format?

How do participants experience the i-DREAMS technology (i.e. user experience, user acceptance)?

3.8.3 The hypothesis

The STZ phases are identifiable and can be used to trigger interventions using the *i*-DREAMS platform. There will be a discernible difference in driving performance (in a simulated environment) between baseline (no intervention) and when the technology is activated and this can be measured using the data collection techniques.

3.8.4 KPIs

The exact KPIs have not been defined yet but will all relate to the successful collection of data (both baseline and STZ conditions) in the simulated environment.

A specific set of scenarios and conditions can be selected which best demonstrate the STZ and allow for differentiation in performance between when the *i*-DREAMS platform is in use compared to baseline.

User feedback information (qualitative) on the acceptance of the *i*-DREAMS technology.

3.9 Task 5.4. On road testing

3.9.1 The aims and objectives

To conduct FOTs testing the *i*-DREAMS platform with 4 different vehicle modes in 5 countries by successfully capturing all the necessary:

- indicators
- performance metrics
- interventions characteristics

3.9.2 The key research questions the task is addressing

Do the *i*-DREAMS platform interventions return the driver back to the STZ phase of normal driving?

3.9.3 KPIs

The exact KPIs have not been defined yet but will all relate to the successful collection of data (both baseline and intervention conditions) in the on-road trials.

3.10 Task 5.5. Big Data processing and analysis

3.10.1 The aims and objectives

- Develop a framework for Big Data processing and analysis.
- Analyse data from simulators and field trials.
- Data fusion.
- Draw conclusions from previous tasks in the work package.

3.10.2 The key research questions the task is addressing

What are the relevant techniques to develop a framework to process, analyse and fuse the data collected from the simulator and field trials?

3.10.3 KPIs

- Operationalised model for the STZ.
- Comparison of KPIs across modes, countries, scenario, etc.

3.11 Task 6.1 Analysis of task complexity

3.11.1 The aims and objectives

<u>Aim</u>: conduct an exploratory analysis to identify the effects of context specific factors on crash risk and the variables associated with task complexity.

<u>Objectives:</u>

- To identify the effect of different context factors on task complexity for different travel modes and operator characteristics.

- To develop and test a pilot structural equation model of the effect of task complexity on the STZ.

3.11.2 The key research questions the task is addressing

What effect do the context measures have on crash risk?

How do the individual context measures relate to the calculation of task complexity?

What influence does the task complexity have on the STZ phases?

3.11.3 KPIs

The structural equation model; description of which context factors affect the phase of the STZ.

3.12 Task 6.2. Analysis of coping capacity vehicle state

3.12.1 The aims and objectives

Aim: To analyse the effect of vehicle state factors on drivers' coping capacity so as to find the most critical for safety.

Objectives:

- Extract the appropriate variables to estimate vehicle state based on indicators, specifications and actuators.
- Identify the most indicative ones for estimating vehicle state.
- Test and validate the mathematical model of the STZ using real-world and simulated data.
- Update and make recommendations on the model based on the experiments.

3.12.2 The key research questions the task is addressing

How can vehicle state be evaluated with regards to driver coping capacity?

3.12.3 KPIs

Feature selection information; accuracy; validity; statistic properties of the model.

3.13 Task 6.3. Analysis of coping capacity operator state

3.13.1 The aims and objectives

Aim: To analyse the effect of operator state factors on drivers' coping capacity to find the most critical for safety.

Objectives:

- Extract the appropriate variables to estimate operator state based on indicators, specifications and actuators.
- Identify the most indicative ones for estimating operator state.
- Test and validate the mathematical model of the STZ using real-world and simulated data.

- Update and make recommendations on the model based on the experiments.

3.13.2 The key research questions the task is addressing

How can operator state be evaluated with regards to driver coping capacity?

3.13.3 KPIs

Feature selection information; accuracy; validity; statistic properties of the model.

3.14 Task 6.4 Synthesis of risk factors

3.14.1 The aims and objectives

Aim: To integrate "task complexity" and "operator capacity" into an integrated model for estimating safety.

Objectives:

- Combine "task complexity" and "operator capacity" into a mathematical model.
- Quantify the effect of the aforementioned factors on driving risk and STZ.
- Identify the impact of driver, vehicle and context factors on STZ in real-time.

3.14.2 The key research questions the task is addressing

Could task complexity and coping capacity factors be simultaneously integrated for estimating safety?

3.14.3 KPIs

Accuracy; model performance.

3.15 Task 7.1. Evaluation of safety interventions

3.15.1 The aims and objectives

Aim: To provide a methodology for safety intervention evaluation within the boundaries of the STZ

Objectives:

- Identify the critical specifics of each safety intervention with regards to safety tolerance.
- Quantify the effect of the interventions during safety-critical events across modes.

3.15.2 The key research questions the task is addressing

How can safety interventions be evaluated in terms of keeping the driver within safe boundaries?

3.15.3 KPIs

Feature selection; technological efficiency; user evaluation; obtrusiveness; before/after evaluation metrics.

3.16 Task 7.2. Evaluation of driver feedback and gamification interventions

3.16.1 The aims and objectives

To carry out an outcome and process evaluation to identify the successful components of post-trip interventions.

3.16.2 The key research questions the task is addressing

How effective (in terms of improvements on safety and potentially other outcomes) are the *i*-DREAMS post-trip interventions for different transport modes and between countries?

What is the added value of a gamified platform in addition to regular feedback by means of the smartphone?

Which components of the post-trip interventions were more or less effective?

How long does it take before interventions start to create an effect?

How long do interventions last (effectiveness duration) when they are no longer presented to the user?

What do we learn from this effectiveness evaluation for the creation of future post-trip interventions?

Acceptability of the different post-trip interventions?

3.16.3 The hypothesis

Gamification will increase the level of participation, interaction and effectiveness of post-trip interventions.

Gamified interventions will create a stronger internal motivation to continue safe (and eco-efficient) behaviour compared to feedback alone.

3.16.4 KPIs

- Levels of intervention uptake.
- Effectiveness of different post-trip intervention strategies and components.
- Evolution of effectiveness duration.

3.17 Task 7.3 Evaluation of active driving interventions

3.17.1 The aims and objectives

Aim: To compare baseline and intervention data to assess the intervention's effectiveness on driver behaviour and state.

Objectives:

- To conduct multi-variate analysis to estimate effect sizes on outcome variables.
- To compare interventions within each test site and overall to calculate effectiveness.

3.17.2 The key research questions

What is the effect of the interventions on driver behaviour and state?

Are there any differences between countries?

3.17.3 KPIs

Multi-variate analysis output

3.18 Task 7.4 Synthesis of measures evaluation

3.18.1 Aims and objectives

Aim: to summarise the *i*-DREAMS intervention evaluation results

Objectives:

- Provide an assessment and ranking of the interventions.
- Identify the most promising intervention schemes for improving driver behaviour and state for each mode.
- Take into account user feedback in the intervention's evaluation.

3.18.2 The key research questions

What are the most effective interventions per mode?

Which interventions received the best user feedback?

3.18.3 KPIs

Ranking the interventions, synthesis of results, user feedback metrics.

4 Study design

This section will briefly highlight the complexity of the *i*-DREAMS study design, this will help to make it apparent why it is necessary, even at this relatively early stage of the project, to create checklists and start finalising the simulator (Section 5) and on-road trials (Section 6) more clearly. As well as why highlighting and addressing legal, ethical and insurance issues which might be barriers to study implementation (Section 7) and identifying communication plan content (Section 8) will be essential to keep the project moving forward and for sharing information smoothly.

5-COUNTRY STUDY
Duration: 12 months

	BE	DE	EL	PT	UK	*Total per mode*
Car	50	75	75		80	280
Bus				100		100
Truck	100			50		150
Rail					70	70
Total per country	150	75	75	150	150	600

STAGE 1: SIMULATOR
Duration: 2 months

	BE	DE	EL	PT	UK	*Total per mode*
Car		15	15			30
Bus				30		30
Truck	30					30
Rail					20	20
Total per country	30	15	15	30	20	110

STAGE 2: FIELD TRIAL
PILOT* - Duration: 1 month

	BE	DE	EL	PT	UK	*Total per mode*
Car		5	5		5	15
Bus				5		5
Truck	5					5
Rail					5	5
Total per country	5	5	5	5	10	30

STAGE 3: FIELD TRIAL
BASELINE MEASUREMENT - Duration: 2 months

	BE	DE	EL	PT	UK	*Total per mode*
Car	50	65	65		85	265
Bus				75		75
Truck	75			50		125
Rail					50	50
Total per country	125	65	65	125	135	515

STAGE 4: FIELD TRIAL
IMPLEMENTATION INTERVENTIONS – Duration: 7 months

	BE	DE	EL	PT	UK	*Total per mode*
Car	50	65	65		85	265
Bus				75		75
Truck	75			50		125
Rail					50	50
Total per country	125	65	65	125	135	515

Figure 4: The four stage, five country protocol

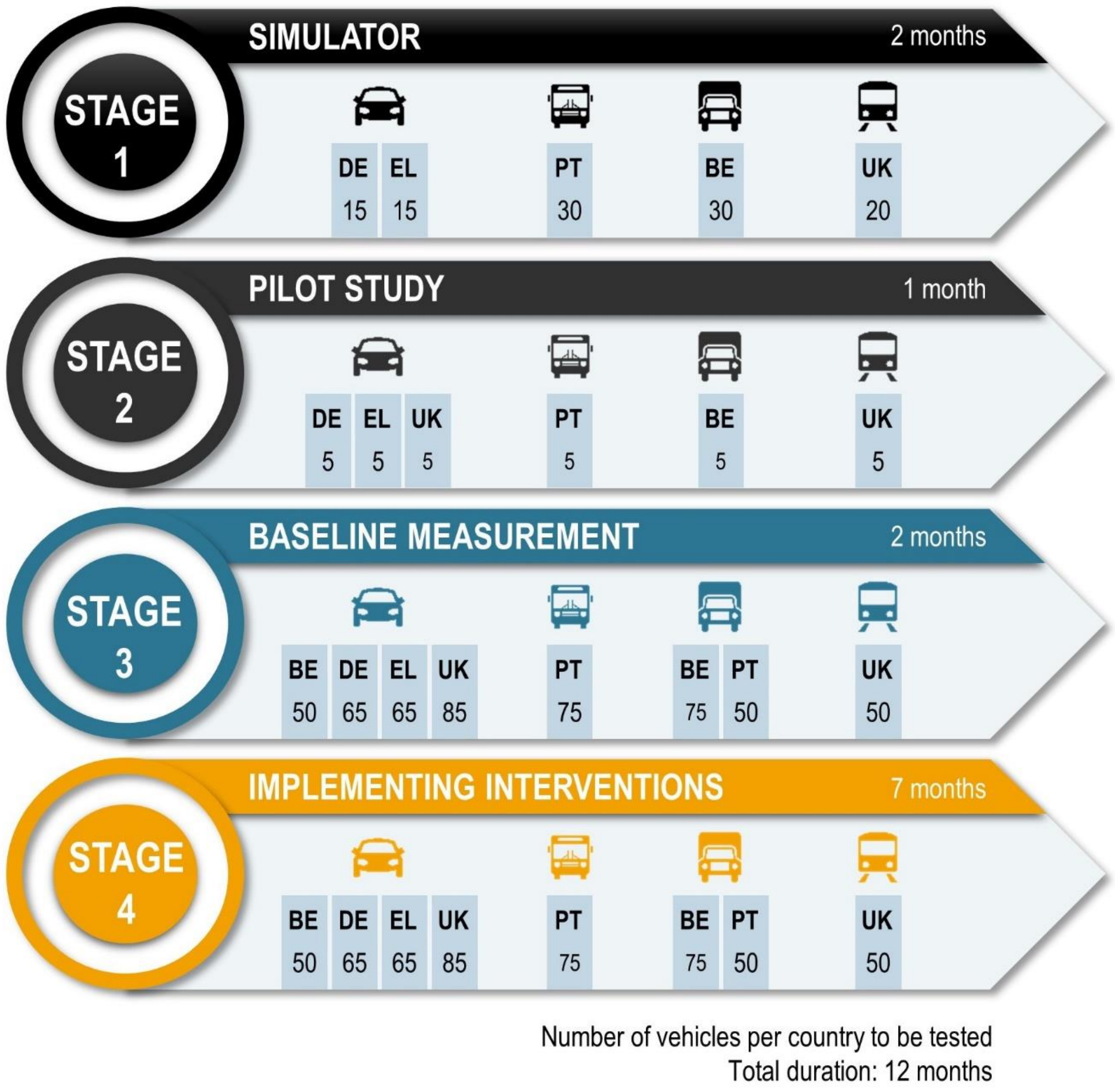


Figure 5: The four stage, five country study design

As shown in Figure 4 and Figure 5, there will be 4 stages involved in the *i*-DREAMS study design. Firstly, there will be a simulator study phase to pilot the projects' technology, ensure it works effectively, can validate the STZ model in the way intended and is feasible to carry out in the scope currently planned in the time and budget available. The simulator trials will occur across five sites with Germany and Greece conducting the car simulator trials, Portugal the bus simulator trials, Belgium the truck simulator trails and the UK the rail simulator trials. These simulator trials will occur over a two-month period. 110 participants are intended to be trialled in total and Figure 5 gives a breakdown of how these are split across transport types and sites.

Once the simulator trials are complete and lessons to be learnt have been consolidated, shared and addressed the on-road trials pilot phase will begin. This will first have a pilot phase with 30 participants in total, although it should be noted that due to possible issues with fitting equipment onto trains and trams it may be the case that it will not progress to real on-rail trials phase but instead more detailed simulator work may be conducted. This pilot phase has an intended 1-month duration.

As the *i*-DREAMS on-road element is going to be a FOT and the equipment will be used in a naturalistic (non-experimental conditions) manner it is important to collect baseline data in order to have something to compare the driving performance with the *i*-DREAMS platform in use against. There is intended to be 515 participants across the 4 transport modes all having their baseline performance collected. It is important to note that for both baseline and the actual intervention implementation (unlike in the simulator trial phase) there will be four trial sites collecting car data (Belgium, Germany, Greece and the UK), and for trucks two sites will be collecting data (Belgium and Portugal). This baseline data collection period will run for 2 months in total.

Finally, the actual intervention will use the same 515 participants as the baseline condition but with the *i*-DREAMS technology platform will be introduced in phases (see Section 6 for more information). This implementation intervention will occur over a 7-month period.

Table 3: Purpose of study design by phase

Method	Purpose
Real world data (based on archive/ legacy data)	Validate STZ mathematical model
Simulator	Validate STZ mathematical model (only required if real world archive/ legacy data is not sufficient/ feasible)
Simulator	Test that the STZ is observable; ensure *i*-DREAMS technology platform can detect different phases of STZ model; user acceptance/ feedback on the *i*-DREAMS technology
Pilot (on-road)	Find timescale of fitting technology, identify issues with equipment use and data processing methodology
Baseline (on-road)	Collect data with no *i*-DREAMS platform in operation for comparison to when it is in action
Intervention (on-road)	Test if *i*-DREAMS platform influences driver safety, validate STZ theoretical model in a real-world environment

Table 3 shows proposed phases for the *i*-DREAMS studies. It has recently been identified that in order to develop the STZ mathematical models there needs to be relevant data put into the algorithm to ensure it can accurately inform on and predict when someone is in each phase of the model and therefore give feedback when needed to change driver behaviour. This may first be attempted with real-world legacy data that is already accessible (i.e. from previous studies) but as it may not be feasible to find data with all the required variables an amalgamation of data sets may be required. This still may not give sufficient clarity to accurately test the model due to not having all the parameters needed. If this is the case earlier simulator trials to gather data, with and without the *i*-DREAMS technology platform running, will be used to 'feed' the model the required data and validate its prediction ability. The exact timing and scope of this phase has not yet been established but it is acknowledged it will need to have enough data to give the model prediction power and happen sufficiently early as to allow contingency time for model re-development should it find the STZ mathematical models, as currently proposed in D3.2, require further refining.

For further information on the steps required for the project to achieve its complex goals please also see the *i*-DREAMS Project Critical Pathway diagram (Annex 2) which helps to visually illustrate the many steps the project design has to meet.

It should be noted that the incentive and recruitment plans will be covered in Task 5.2 so no conclusive decisions or information can be given regarding these in this deliverable and will not be covered in the following simulator or FOT planning sections.

5 Simulator trial planning

5.1 Simulator overview and progress

DSS is developing and building two new driving simulators for the *i*-DREAMS project, one car simulator and one bus/truck simulator. The simulators will be more than just tools to test driving behaviour, they will also function as a test bench for *i*-DREAMS equipment such as CardioWheel and Mobileye and to test out technologies for the real-time interventions. Because the project is still at an early stage the simulators had to be designed in a way such that they can easily be equipped and expanded with the technologies that will eventually be used in the project. Both simulators will use STISIM Drive 3 software, which allows creating interfaces with external equipment, as well as logging and exportation of many variables that can be used for future analysis in Work Packages 6 and 7.

5.1.1 Car simulator

The car simulator (Figure 6) is based on a Peugeot 206 and uses OEM parts such as the driver seat, dashboard, instrument cluster and blinker unit. For this simulator a new design approach was chosen, using aluminium T-slot profiles. This makes the simulator easy to be assembled and disassembled, which facilitates transportation of the simulator. This is a specific constraint of the *i*-DREAMS project as the simulator studies will take place in multiple countries. The T-slot profiles also create a modular platform that can easily be expanded with new hardware in case this should be needed for the simulator experiments.

Figure 6: DSS Car simulator, using OEM Peugeot 206 parts

One of the challenges of this build was to incorporate as many authentic OEM parts as possible. This involved the fabrication and 3D printing of various mechanical parts and development of custom printed circuit boards (PCBs) for interfacing the OEM controls with the simulator software.

The build of the car simulator is nearing completion with several functional tests already being successfully performed, parts for the finalisation of the simulator have been ordered and are being fabricated.

5.1.2 Large vehicle simulator

The second simulator consists of a universal setup that can be used for both truck and bus simulation (Figure 7). For this simulator it was decided not to use a complete OEM dashboard/cockpit. After careful consideration this decision was based on the conclusion that OEM truck/bus parts are much larger and heavier than OEM car parts, this would make the simulator heavy and impractical to transport. Instead, research on realistic driving positions in trucks/busses was performed. The resulting driving position will be replicated in the mock-up. To optimise the simulator for a realistic feel, certain OEM truck parts such as the steering wheel and driver seat will be used.

Figure 7: DSS large vehicle simulator

Following the same design principle as the car simulator, the heavy vehicle simulator frame will also be constructed out of aluminium T-slot profiles, offering the same level of modularity but even more adjustability of the driving position. The design of the heavy vehicle simulator has been finished and parts are currently in order and being fabricated. The simulator will feature a truck/bus vehicle dynamics model to offer realistic vehicle behaviour. This model will be tested and co-developed by experienced truck and bus drivers.

Both simulators should also be able to interface with other equipment that will be used in the *i*-DREAMS platform. This includes Mobileye and CardioWheel, for which testing and development is currently being performed to integrate their data in the simulator software. In order to provide interchangeability between the simulator and cars/buses/trucks, options to expand the simulators with communication interfaces such as CANbus and OBDII that act as a gateway between simulator and equipment are being investigated.

5.2 Resource planning

The number of participants in the simulator experiments is relatively low compared to the on-road experiment because the simulator experiment will effectively act as a pilot study rather than a full experimental study. During the simulator experiment, the focus will be on pilot testing the *i*-DREAMS technology and get a first evaluation of user experience and acceptability in order to fine-tune technologies before on-road testing takes place, it may also be used prior to this to help fine tune the STZ model if appropriate archive data from on-road studies cannot be found. In the simulator situations can also be simulated that would not be ethically acceptable on-road, offering the possibility for certain features of the *i*-DREAMS platform to be tested which cannot occur in the road trials.

Simulator experiments will take place in 5 different countries: Belgium, Germany, Greece, Portugal and the United Kingdom. 4 modes (car, bus, truck and rail) will be evaluated. An overview of which mode is evaluated in which country is shown in Figure 8. A more detailed outline regarding installation and resources for the different experiments is given in Section 4 detailing the study design.

STAGE 1: SIMULATOR*
Duration: 2 months

	BE	DE	EL	PT	UK	*Total per mode*
Car		15	15			30
Bus				30		30
Truck	30					30
Rail					20	20
Total per country	30	15	15	30	20	110

* simulator participants are excluded from field trial

Figure 8: Simulator experiment participant numbers overview

5.2.1 Belgium

In Belgium 30 truck drivers will take part in the simulator experiment. For this experiment the truck/bus simulator developed and built by DSS for *i*-DREAMS will be used. See Annex 3: DSS driving simulator specifications for a detailed description of the truck/bus simulator. The experiment will be carried out by UH and the simulator will be prepared with *i*-DREAMS technology and installed at UH by DSS. The simulation scenarios will be programmed by DSS, based on input from previous work packages. Because the same simulator will be used for the bus driver experiments in Portugal, testing in Belgium and Portugal cannot take place at the same time.

5.2.2 Germany

In Germany 15 car drivers will take part in the simulator experiment. For this experiment, the car simulator developed and built by DSS for *i*-DREAMS will be used. See Annex 3: DSS driving simulator specificationsfor a detailed description of the car simulator. The experiment will be carried out by TUM and the simulator will be prepared with *i*-DREAMS technology and installed at TUM by DSS. DSS will arrange transport of the simulator from Belgium to Germany. The simulation scenarios will be programmed by DSS, based on input from previous work packages.

5.2.3 Greece

In Greece 15 car drivers will take part in the simulator experiment. For this experiment, the car driving simulator owned by NTUA will be used. See Annex 4: FOERST driving simulator specifications for a detailed description of the simulator. NTUA will also install and prepare the simulator and carry out the experiment. The simulation scenario will be programmed by NTUA, based on input from previous work packages.

5.2.4 Portugal

In Portugal 30 bus drivers will take part in the simulator experiment. For this experiment, the truck/bus simulator developed and built by DSS for *i*-DREAMS will be used. See Annex 4: FOERST driving simulator specifications for a detailed description of the simulator. The experiment will be carried out by Barraqueiro Transporte, S.A. and the simulator will be prepared with *i*-DREAMS technology and installed by DSS. DSS will arrange transportation of the simulator from Belgium to Portugal. The simulation scenarios will be programmed by DSS, based on input from previous work packages. Because the same simulator will be used for the bus driver experiments in Portugal, testing in Belgium and Portugal cannot take place at the same time.

5.2.5 United Kingdom

In the United Kingdom 20 rail drivers will take part in the experiment. For this experiment a third-party train simulator will be used at the rail operator, the exact specification of the simulator is yet to be shared with the project by the train company but it is a commercial quality simulator used for the training of rail drivers. Loughborough University, supported by advice from DSS where possible, will carry out the experiment and coordinate scenario design and preparation of the rail simulator with *i*-DREAMS technology.

5.3 Experiment design

At the current stage of the project additional information is still needed for the definition of driving scenarios and the design of the experiment, the information that needs to be decided upon will be the result of research and conclusions from WP3. An overview of the required information and the tasks in which it will be addressed in the project is given below:

5.3.1 Target risks – output from T3.4

For each mode, specific target risks to focus on need to be defined. Ideally these target risks should be based on the result of the stakeholders' survey (D9.1) and a collection of crash statistics. From the results of the stakeholder survey, it appears that for trucks and coaches, close following another vehicle is a frequently reported problem, whereas for cars the most reported collision type involves vulnerable road users. The selection of target risks should take into account the technical possibilities of the driving simulator and the sensor technologies to be installed.

5.3.2 Typical scenario environments – output from T3.4

Based on the selection of target risks per transport mode, typical virtual road environments and situations/events need to be created. For example: Vehicle following scenario on motorway for trucks and coaches, city driving for bus, a car overtaking a cyclist on a shared lane etc.)

5.3.3 Conditions to evaluate – output T3.4

What are the conditions or events we want to evaluate? For example: following a vehicle with constant or varying speed, cyclist overtaking with cyclist driving straight or cyclist making evasive moves.

5.3.4 Evaluation criteria – output T3.4

What are the criteria we want to evaluate in the simulator experiment? (*i*-DREAMS technology vs no *i*-DREAMS technology, collision rate, reaction time, driving behaviour etc.)

5.3.5 Real-time interventions – output T3.3

Which modality do we want to use for real-time interventions (auditory, haptic, visual) and what should be the content of the message? (specific vs non-specific, icons vs text, speech vs auditory beep).

Which technology should be used to give the real-time intervention? (steering wheel force feedback, sound generator, external display such as tablet or smartphone etc.)

These interventions need to be selected for the 3 different stages of the STZ and it needs to be decided whether there will be a difference between them for each mode and/or target risk.

5.3.6 Thresholds – output T3.1

Definition of parameters, and threshold values for these parameters, that will be used to move through the different stages of the STZ (normal driving, danger phase, avoidable crash phase).

5.3.7 Dynamic probabilistic model – output T3.2

A first version of the dynamic probabilistic model needs to be defined and coded so it can be tested in the simulator. This will define how the thresholds change is recognised by each function e.g. drowsiness level as measured by the CardioWheel or other sensory inputs.

It also needs to be decided whether this version will run on the simulator computer or whether it will already be running on hardware that will eventually be used for the implementation of the *i*-DREAMS platform in real vehicles.

5.4 Measurement and data collection

During the simulator experiment, data will be automatically collected. This data will be saved and will be used for evaluation. DSS is currently performing testing with the core *i*-DREAMS technology, Mobileye and CardioWheel with the goal to integrate this external data in the LOG-files that are automatically generated by the simulation. It is essential to create a (time)link between the measures from all the different technologies. The gross part of measures that will be collected is already known, but can still be expanded or changed, depending on the decision on what technologies that will be used. An overview of measures is given below:

5.4.1 Driving parameters collected from the simulator software

The simulator software automatically collects driving parameters at frame rate (+/-60 Hz). These parameters are linked to time and include: travelled distance, speed, acceleration, steering inputs, brake input, lateral positions etc. For a detailed overview of possible parameters see:

- Annex 5: STISIM 3 parameter overview for the car and bus/truck simulators to be used at UHASSELT, TUM and BARRA.
- Annex 6: F10 driving software parameter overview for the car simulator to be used at NTUA.
- **Error! Reference source not found.** for the train simulator to be used at LOUGH are till pending.

5.4.2 CardioWheel data

Raw ECG values and measures that are derived from the raw ECG signal, for example, drowsiness scale (KSS scale) will be collected from the CardioWheel.

5.4.3 Mobileye data

The Mobileye will be used as a "sensor" that measures parameters like headway distance. Information about the current warning stage, as defined by Mobileye, will also be collected for comparison with the *i*-DREAMS warning stage (normal driving, danger phase, avoidable crash phase).

5.4.4 *i*-DREAMS platform state

Information will be collected about the current state of the *i*-DREAMS platform, this includes the stage of the STZ and which warning has been triggered at what time.

5.4.5 Video and sound recordings

GoPro cameras will be used during the simulator experiments to capture video and sound. This footage can later be used for data validation and triangulation.

5.4.6 Questionnaire data

Prior and after the experiment, participants will be asked to fill in a questionnaire to get more detailed information about their profiles (e.g. age, gender, driving experience etc.) and to poll for subjective measures (e.g. platform usefulness, user satisfaction with different platform components).

5.4.7 Eye Tracking (optional)

Using eye-tracking equipment (Tobii Pro glasses) is optional, a decision on whether to use it during the simulator experiment needs to be decided. Eye tracking parameters (e.g. gaze points, glance duration) would be used as an extra tool for evaluation in the simulator experiment only.

5.5 Simulator experiment timing

An overview of the different subtasks needed for the simulator experiment is given below. This overview is based on the original Gantt-chart from the project proposal, which was described in more detail by the partners involved in WP5.

5.5.1 Equipment installation/calibration/benchmarking among partners

Timing: 12/2019 – 04/2020

Lead: DSS

Support: UHASSELT, NTUA, LOUGH, BARRA, TUM, CARDIOWHEEL

Description

Simulators need to be built. They should be equipped with *i*-DREAMS technology (Mobileye, CardioWheel, intervention technology etc.). A method to integrate *i*-DREAMS measures with data logged in the simulator should be made. Partners who are not familiar with using the simulator and will be performing simulator experiments need to be trained. Simulators should be installed at the locations where the simulator experiments will be performed.

DSS is responsible for this subtask for the car simulator that will be used at TUM and the truck/bus simulator that will be used at UHASSELT and BARRA. Based on these installations DSS will provide support (where possible) to LOUGH and NTUA for their rail and car simulators.

LOUGH is responsible for coordination of this task for the rail simulator that will be used in cooperation with the rail operator.

NTUA is responsible for this task for the car simulator that will be used at NTUA.

Status

Testing to integrate Mobileye and CardioWheel with the simulator is ongoing, together with evaluation of methods to interface with other equipment (CANbus, OBDII). The DSS Car simulator is built and nearing completion, planned completion is 12/2019. The DSS Truck/bus simulator has been designed and is ready for production, which is planned 12/2019. The completion of the truck/bus simulator is planned 02/2020. Once a decision has been made on which technologies to use, design of intervention platforms can start. Timing of the installations depends on finalisation of subtask 5.1.1, but could start as soon as 01/2020, with exception to the bus simulator at BARRA because this will be the same simulator that will be used at UHASSELT. Installation of the bus simulator at BARRA will start after the experiment at UHASSELT finished. Because of this, the early finalisation of the simulation subtask would be beneficial in order to avoid stretching the timing for the simulator experiments at BARRA.

5.5.2 Simulations organisation

Timing: 05/2020 – 10/2020

Lead: DSS

Support: UHASSELT, NTUA, LOUGH, BARRA, TUM

Description

For all the simulators, a detailed test protocol should be created for identifying the STZs and the performance of in-vehicle interventions. Based on this protocol, one or more driving scenarios should be programmed. This subtask also includes the creation of D5.2.

DSS will be responsible for the test protocol and scenario creation for the car simulator at TUM and the truck/bus simulator at UHASSELT and BARRA. Based on this, DSS will also provide support (where possible) to NTUA and LOUGH for their car and rail simulators.

LOUGH is responsible for coordination of this task for the rail simulator that will be used in cooperation with commercial rail companies.

NTUA is responsible for this task for the car simulator that will be used at NTUA.

Similar protocols will be followed across test sites and transport modes as much as possible, ensuring data can be combined for the analysis stage.

Status

Waiting for completion of subtask 5.1.1 to start this subtask.

5.5.3 Driving simulator testing

Timing: 11/2020 – 06/2021

Lead: DSS

Support: UHASSELT, NTUA, LOUGH, BARRA, TUM

Description

This task involves the actual simulator experiments which will be used to pilot test *i*-DREAMS technology and to get a first evaluation of user experience and acceptability of the technology.

Status

Subtasks 5.1.1 – 5.1.2 – 5.1.3 (preparations of the simulator experiment and subtask 5.2.3 (recruitment) need to be completed before this subtask can start).

Start of this task is planned for 11/2020 but if timely finalisation of previous subtasks allows it, DSS provisionally plans to start this task as soon as 05/2020 to avoid extending the timing for the simulation experiment at BARRA.

6 On-road trial planning

6.1 Background

In the *i*-DREAMS project, field experiments with a group of 600 drivers/operators in total will be carried out in 5 EU countries. In the proposal, the following experimental protocol was included for which the equipment and logistical aspects need to be further discussed and defined.

Field experiments will include 4 stages with a total duration of 12 months, including Stage 1: simulator (total duration: 2 months), Stage 2: pilot (total duration 1 month), Stage 3: baseline measurement (total duration 2 months) and stage 4: testing of interventions (total duration 7 months). Stage 2, 3 and 4 take place on the road. Stage 1 takes place in a driving simulator environment.

Interventions in Stage 4 include in-vehicle and post-trip interventions. It should be noted that no intervention will occur in the 'unavoidable crash' phase of the STZ for safety and liability reasons. For post-trip interventions in Stage 4, a distinction is made between personalised feedback via the smartphone and personalised feedback via the smartphone combined with a gamified web-platform. Each of the participants taking part in the on-road field experiments will experience each of these interventions.

6.2 Experimental protocol

An overview of the timing and planning of the on-road trials will be highlighted (Table 4). This is a proposal for the logistical aspects of the on-road experiment, taking into account the availability of equipment as budgeted in the proposal, and the logistical efforts needed to install (and de-install) the equipment in the vehicles. The table also shows how the different stages that are planned for groups of participants. The codes in Table 5 should be interpreted as shown in Table 4.

Table 4: On-road trials overview table

Code	Description	Duration per participant
F2	Pilot testing	4 weeks
F3	Baseline measurement (no interventions)	4 weeks
F4-i1	In-vehicle intervention	4 weeks
F4-i2	Post-trip feedback on smartphone	4 weeks
F4-i3	Post trip feedback on smartphone + gamified web platform	6 weeks

All drivers taking part in the intervention stage of the study (F4) will also participate in the baseline measurement phase (F3) where no interventions are implemented (driving performance is recorded but no *i*-DREAMS intervention technology is in use, i.e. their performance is monitored but no alerts received). A limited number of pilot vehicles are equipped to pilot-test in phase 2 (F2) the measurement equipment and interventions before the real experiment starts. In order to not influence the results of the real experiment (F3+F4), drivers taking part in the pilot study (F2) will not be retained for F3 and F4, they will have used the *i*-DREAMS technology platform in this pilot and so will not be eligible to be part of the main study.

The overview table below also shows different test groups of drivers (G1, G2) and the week numbers (W1, W2, etc) when each group is taking part in the study. An 'X' indicates that the test group does not participate in the experiment during certain time periods.

Finally, the overview table shows the logistics for the different EU countries involved in the on-road experiments.

As can be seen in Table 5, car pilot-testing will take place in Germany, Greece and the UK only. For truck pilot tests will be run in Belgium, Bus pilots will take place in Portugal and rail pilots in the UK, all pilots will feature 5 participants for each mode in their respective test country.

In the main trial (F4-i1 to F4-i3) for logistical reasons two trial groups will be used in all modes of transport and across all sites sequentially, meaning less equipment is required to be purchased than if participants were tested at the same time. The logistics of this, as shown in Table 5, will be illustrated using Belgium's car trials as an example. 50 car drivers will be tested on the road who are subdivided in two groups (G1 and G2). The first group (G1) of 25 drivers will start in week 5 (W5) for the baseline measurement phase (F3) during a period of 4 weeks (from W5-W8), after which they will complete all intervention programs (F4-i1, F4-i2 and F4-i3) from W9-22. When the drivers in Group 1 are finished, a de-installation of equipment in G1 and installation of the same equipment for G2 takes place in W23-W24. Once installed, G2 repeats the same process as G1 (F3, F4-i1, F4-i2, F4-i3) from week W25-W42. After W42, the equipment in Group 2 can be de-installed from the vehicles. The reason for having two groups of drivers per mode is that otherwise we need double the equipment (which was not budgeted).

Table 5: Time plan for on-road trials

BELGIUM																	
CAR			install G1 (25)	G1 (25)	W5-W8 (F3)	W9-W12 (F4-i1)	W13-W16 (F4-i2)	W17-W22 (F4-i3)	de-install G1 (25)	X	X	X	X		25 car devices + 38 truck devices	→	total devices = 63
				G2 (25)	X	X	X	X	install G2 (25)	W25-W28 (F3)	W29-W32 (F4-i1)	W33-W36 (F4-i2)	W37-W42 (F4-i3)	de-install G2 (25)			
															50 car installs + 80 truck installs	→	total installs = 130
TRUCK	install pilot (5)	W1-W4 (F2)	deinstall Pilot + install G1 (38)	G1 (35)	W5-W8 (F3)	W9-W12 (F4-i1)	W13-W16 (F4-i2)	W17-W22 (F4-i3)	de-install G1 (38)	X	X	X	X				
				G2 (35)	X	X	X	X	install G2 (37)	W25-W28 (F3)	W29-W32 (F4-i1)	W33-W36 (F4-i2)	W37-W42 (F4-i3)	de-install G2 (37)			5 install moments
Germany																	
CAR	install pilot (5)	W1-W4 (F2)	install G1 (33)	G1 (30)	W5-W8 (F3)	W9-W12 (F4-i1)	W13-W16 (F4-i2)	W17-W22 (F4-i3)	de-install G1 (33)	X	X	X	X		33 car devices	→	total devices = 33
				G2 (30)	X	X	X	X	install G2 (32)	W25-W28 (F3)	W29-W32 (F4-i1)	W33-W36 (F4-i2)	W37-W42 (F4-i3)	de-install G2 (32)			
															70 car installs		3 install moments
Greece																	
CAR	install pilot (5)	W1-W4 (F2)	install G1 (33)	G1 (30)	W5-W8 (F3)	W9-W12 (F4-i1)	W13-W16 (F4-i2)	W17-W22 (F4-i3)	de-install G1 (33)	X	X	X	X		33 car devices	→	total devices = 30
				G2 (30)	X	X	X	X	install G2 (32)	W25-W28 (F3)	W29-W32 (F4-i1)	W33-W36 (F4-i2)	W37-W42 (F4-i3)	de-install G2 (32)			
															70 car installs		3 install moments
PORTUGAL																	
TRUCK			install G1 (25)	G1 (25)	W5-W8 (F3)	W9-W12 (F4-i1)	W13-W16 (F4-i2)	W17-W22 (F4-i3)	de-install G1 (25)	X	X	X	X		25 truck devices + 38 bus devices	→	total devices = 60
				G2 (25)	X	X	X	X	install G2 (25)	W25-W28 (F3)	W29-W32 (F4-i1)	W33-W36 (F4-i2)	W37-W42 (F4-i3)	de-install G2 (25)			
															50 truck installs + 80 bus installs	→	total installs = 130
BUS	install pilot (5)	W1-W4 (F2)	deinstall Pilot + install G1 (38)	G1 (35)	W5-W8 (F3)	W9-W12 (F4-i1)	W13-W16 (F4-i2)	W17-W22 (F4-i3)	de-install G1 (38)	X	X	X	X				
				G2 (35)	X	X	X	X	install G2 (37)	W25-W28 (F3)	W29-W32 (F4-i1)	W33-W36 (F4-i2)	W37-W42 (F4-i3)	de-install G2 (37)			5 install moments
UK																	
CAR	install pilot (5)	W1-W4 (F2)	install G1 (43)	G1 (40)	W5-W8 (F3)	W9-W12 (F4-i1)	W13-W16 (F4-i2)	W17-W22 (F4-i3)	de-install G1 (43)	X	X	X	X		43 car devices + 25 rail devices	→	total devices = 65
				G2 (40)	X	X	X	X	install G2 (42)	W25-W28 (F3)	W29-W32 (F4-i1)	W33-W36 (F4-i2)	W37-W42 (F4-i3)	de-install G2 (42)			
															90 car installs + 55 rail installs	→	total installs = 145
RAIL	install pilot (5)	W1-W4 (F2)	install G1 (25)	G1 (25)	W5-W8 (F3)	W9-W12 (F4-i1)	W13-W16 (F4-i2)	W17-W22 (F4-i3)	de-install G1 (25)	X	X	X	X				
				G2 (25)	X	X	X	X	install G2 (25)	W25-W28 (F3)	W29-W32 (F4-i1)	W33-W36 (F4-i2)	W37-W42 (F4-i3)	de-install G2 (25)			6 install moments

Note: in the UK for rail a similar test scheme is included to those in Table 5, but the equipment will be dependent on the exact test conditions (simulator or real-world). The example should therefore be interpreted with caution for rail.

The overview table also shows the total number of installations, installation moments and devices needed for each mode and country. The number of installations is based on the principle of ‘one vehicle – one driver’. Significant scale economies can be achieved if multiple drivers can operate the same vehicle. In that case, only one installation needs to be carried out per vehicle for more than one driver (e.g. two truck drivers using the same vehicle during different shifts of the day, or two of a household driving the same vehicle).

6.3 Installation effort

As can be observed from the overview table, a significant amount of installations (and de-installations) will have to be carried out during the course of the project. The technical aspects of installation in the vehicles will therefore consume significant resources in terms of man hours.

The currently planned installation includes the following components:

- OBD-II logger (capturing vehicle data such as velocity, fuel consumption, acceleration/deceleration, GPS info for trip construction, use of ADAS functions such as cruise control, time of driving, and depending on the model and availability of information on the CANbus potentially many more parameters)
- Mobileye camera + driver interface (logging current speed limit and event warnings such as: lane departure, short headway distance, collision, presence of cyclists and pedestrian in front of the vehicle). Mobileye does not record roadway environment.
- CardioWheel (or CardioShirt or smartwatch): capturing and logging heartrate data for biometric driver identification and indicator of fatigue. Final choice of heart rate monitoring medium is yet to be determined.
- Potentially other equipment currently not defined in the project, such as:
  - Equipment for in-vehicle interventions
  - Windshield camera (/ dashcam) to record roadway environment when Mobileye launches a warning (would allow to identify the precise circumstances of the event).

The installation effort and complexity will be dictated by several factors:

- **Information available on the CANbus** (through the OBD-II connector). Mobileye requires at least the following signals to support its headway monitoring, collision avoidance and lane departure warning capability: turn indicator activation, brake light activation, vehicle speed and activation of wipers. In modern cars, most of these signals are digitally available on the CANbus. In older vehicles, some of these signals are missing on the CANbus and analogue signals have to be found in the vehicle (requiring the removal of vehicle parts, soldering of cables, additional installation and wiring). It does not seem realistic to assume that participants will allow such intrusive installation to take place in their vehicles. Vehicles models (type + year) therefore need to be found in which the installation can be most easily completed using the CANbus only. Although this will require more effort in the recruitment stage to find participants with specific vehicles, it will facilitate significantly the technical installation afterwards.
- **CardioWheel installation**: current installation of CardioWheel appears a challenge with different sizes of steering wheels and preference for a permanent power supply through the vehicle battery and wiring for transfer of heartrate signal. A prototype solution currently exists using an external battery mounted on the back of the steering wheel, but it needs further testing. Other alternatives therefore need to be evaluated

to capture the heartrate (T-shirt, smartwatch)? Hence, the choice of medium for heart rate monitoring is currently still under discussion and may vary based on vehicle type with fleet vehicles (bus and truck) having the CardioWheel design and personal cars and rail another medium. The practicalities of fitment and the considerations of what will least inconvenience participants will be determining factors.

- **Technical expertise of staff carrying out the installation**: installation of the equipment needs to be carried out by a technician trained and certified by CardioWheel to carry out Mobileye installations. Typically, staff will need to have skills to remove certain interior parts (covering) and to work on the electrical wiring of the vehicle. The following options are currently evaluated:
    - Training of local staff in each country by CardioWheel
    - Finding specialised workshops in each country to carry out the installation
    - CardioWheel staff to carry out all the technical installations in each country.
- The **number of vehicles** to be installed: as described in the experimental protocol, the naïve approach is to assume that the number of vehicles equals the number of drivers/operators. However, there might be opportunities for optimisation to reduce the number of vehicles to be installed:
    - **One vehicle is operated by multiple drivers**. In the recruitment process, focus then needs to be on family cars driven by multiple persons in the household, and trucks and buses driven by multiple operators during different shifts.
    - **Rental cars**: for car drivers, the number of installations could be significantly reduced if we do not use their private vehicles but instead provide them with a rented vehicle during the period of experimentation. This way, one equipped vehicle could be passed on to multiple drivers during the year of testing. This will save installation costs but will increase the cost of the experiment because cars will need to be rented for a significant period of time. Positive side to this approach will also be that insurance is covered by the rental.

6.4 Equipment needs and availability

According to the experiment overview table, the following projected amounts of core equipment can be identified (but final numbers will depend on practical considerations identified WP3 and WP4 of the project):

For cars

- OBD-II units 134
- Mobileye units 134
- Smartphones 134 (or can be run on participant’s own smartphone)

For trucks

- OBD-II units[1] 0
- Mobileye units 63
- CardioWheel 63
- Smartphones 63

For buses

- OBD-II units 0
- Mobileye units 38
- CardioWheel 38
- Smartphones 38

For rail

The equipment will need to be adapted for use in rail as the operating procedures and interface for driving a train or tram are very different from the other on-road forms of transport. This is currently still under discussion and development within the project.

Adding the units together across all modes, leads to (slight changes compared to the numbers budgeted in the project proposal between brackets):

- OBD-II units 134 (125)
- Mobileye units 235 (220)
- CardioWheel units 101 (220)
- Smartphones 235 (220)

6.5 Additional equipment to be evaluated

In the project, a contingency budget for equipment was included for a total of 50.000 euro (10.000 euro per partner included in the field experiments). This additional budget enables to include additional equipment when deemed interesting or necessary for the project and could be deployed on a custom basis or on a restricted number of vehicles, such as:

- Windshield mounted camera (/ dashcam): to capture the road environment of the vehicle. This would enable to link Mobileye-generated warning events to real driving conditions.
- Smartwatch or wristbands
- Cardio T-shirt
- Others

[1] In the *i-Dreams* project proposal, it was assumed that trucks and buses would not be equipped with OBD-II units since most of them are already equipped with on-board units capturing already similar data than those collected by the OBD-II device. However, the OBU's do not send out individual event data, only aggregated data per day. Buying an extra 95 OBD-II units for trucks and buses would amount to an extra cost of 10.450 euro for the project.

7 Ethical and legal issues

The following sections detail current progress in identifying rules and regulations for each transport type and in each country the field trials will operate in which might prevent, or need some adaption to allow, the *i*-DREAMS technology platform to be implemented. This is crucial to know at an early stage as any barriers encountered are much easier to overcome at the start of the planning process when technology choices, development and methods to follow are still being decided upon. At this stage it will be possible to take these limitations into consideration and help make an informed decision, as opposed to trying to adapt ill-suited processes and technology further along when adjustments are more difficult and costly to make.

7.1 Legal issues

As the *i*-DREAMS Project will be running simulator and on-road trials across several different vehicle types and in different countries it is necessary to investigate in-depth the laws which might restrict intended plans outlined in previous sections. It is essential to know that the planned trials will comply with local laws so this section details and evidences that possible issues have been considered and what needs to be modified or borne in mind for the planning and running of the study to ensure compliance.

United Kingdom (UK):

Cars: Legal issues for cars were discussed with an ex-police officer who works in Loughborough Design School and is well versed in laws around transport. Where possible the rules and regulations confirming their statements have been provided. UK road perspective is for cars only as no trucks or busses will feature in the UK's data collection.

Rail: For the legal issues of fitting equipment in the railway sector a HM Railway Inspectorate for the Office of Road and Rail (ORR) was interviewed**.** Each operator in the UK rail industry has different rules and operating practices but all must conform to the overarching regulations from the ORR, therefore the answers given in this section apply to all rail operator. The regulations applied by ORR are very general, often requiring a demonstrated risk assessment and implemented control measures to prove compliance.

Belgium (BE): Legal issues were discussed with the Data Protection Officer of Hasselt University, the product manager and telematics expert of AXA Belgium and a traffic legal expert. The Belgian perspective is for cars and trucks.

Germany (DE): Legal issues pertaining to the equipment to be installed were checked against the official state regulations governing private transport in Germany. Insurance-related matters were addressed by identifying major car insurance providers in Germany, specifically the ones active in Munich, examining their terms of services, and eventually contacting them. The German perspective involves cars only.

Greece (EL): Legal issues were discussed with an employee of the Ministry of Infrastructure and Transport, with regards to regulations concerning the installation of sensors in cars.

Portugal (PT): Legal framework and potential liability issues were analysed by surveying existing legislation and regulations and relevant stakeholder consultation. Namely this was with the national mobility and transport institute IMT ("Instituto da Mobilidade e dos Transportes"), the national road safety association ANSR ("Autoridade Nacional de Segurança Rodoviária"), the national association of road transport companies ANTROP ("Associação Nacional de Transportes Rodoviários"), the national data protection commission CNPD ("Comissão Nacional de Proteção de Dados") and the main insurance provider for Barraqueiro Transportes, S.A. buses and coach fleet. Despite being focused mainly on buses, the matters of particular interest to *i*-DREAMS are common to both buses and trucks.

7.1.1 General legal considerations

UK: No general details are needed; all relevant information is contained in the specific sections.

BE: Royal Decree of 15 March 1968 about the general rules on technical conditions of vehicles, Art. 26 states that no vehicle is allowed to be used on the road when it is in a state of maintenance or operation where traffic safety is compromised, irrespective of the vehicle inspections carried out by accredited organisations. This implies that any changes to the vehicle by post-mounting third party equipment should not compromise road safety, and thus should be carried out by a skilled technician authorised to install such equipment.

The same Royal Decree of 15 March 1968, Art. 57.1 stipulates that the field of view of the driver must not be obstructed by any objects or postings.

The Road Traffic Act of 1 December 1975, Art. 8.3 stipulates that drivers must be fit to drive, have the required physical qualities and possess the knowledge and skills required for the driving task. The driver must be constantly able to perform all manoeuvres related to driving.

DE: Legal matters governing road transportation by private means in Germany are regulated among others in the following five laws and regulations:

- The Road Traffic Act (Straßenverkehrsgesetz - StVG), which is a federal law that governs the application area of the rest of the regulations
- The Road Traffic Regulation (Straßenverkehrs-Ordnung - StVO), which sets the rules for all participating parties in road traffic
- The Road Traffic Licensing Regulation (Straßenverkehrs-Zulassungs-Ordnung - StVZO), which regulates the formal and technical requirements for registering vehicles for use on public roads
- The Vehicle Registration Regulation (Fahrzeug-Zulassungsverordnung - FZV), which includes the necessary procedures for the registration and decommissioning of road vehicles and the insurance obligations for motor vehicles
- The Driver's Licensing Regulation (Fahrerlaubnis-Verordnung - FeV), which includes general rules on participation in road transport, including provisions on the admission of persons to road traffic, the restriction and withdrawal of the admission.

The Road Traffic Act [StVG §2(4)] stipulates that drivers must be physically and mentally fit to drive, except on cases where a license with limitations or conditions is issued. They must not violate traffic regulations or other criminal laws significantly or repeatedly. Inability to drive must not be remedied by electronic or other devices.

The Road Traffic Regulation [(StVO I.§23(1)] states that no device may obstruct the view of the driver and that any device with view projection functions may only be used for vehicle-related, traffic-related, journey-related or trip-accompanying information [StVO §23(1a)].

The Road Traffic Licensing Regulations (StVZO) contains instructions on auxiliary equipment that can be mounted on the vehicle. There is no special mention of steering wheel-mounted equipment and on-board diagnostics devices.

The Vehicle Registration Regulation (FZV) and the Driver's Licensing Regulation (FeV) have been significantly amended during the last years, in order to streamline with the regulations of the European Union and to include provisions for vehicles and driver's licenses from other countries of the EU.

EL: No general details are needed; all relevant information is contained in the specific sections.

PT: Currently Portuguese road traffic and vehicle homologation legislation bears strong parallels to the one of its Eurozone counterparts, provided the ever increasing European legislate effort towards the standardisation and harmonisation of legal frameworks within the European Union that enable the free movement of individuals and goods.

Despite the similarities, in Portugal, the legal framework and principles applicable to vehicles, drivers and governing road transportation in public and private roads open to public passage is regulated by a myriad of laws, decrees and regulations that seldom allow for interpretations distinct from the ones observed in other countries where the trials will take place.

The Road Traffic Regulations/Road Code ("Código da Estrada") established by the Decree-Law 114/94, in its latter form resulting from the amendments published by the Decree-Law 02/2020, sets the rules for all participating parties in road traffic. The code states that, with a few well-defined exceptions, the driver bear sole responsibility for its driving actions, whenever it can be identified. When the driver cannot be identified the vehicle owner is then liable for the driver's action. For the case of professional drivers, violations directly and verifiably mandated by the employer can exonerate the driver from its actions liability.

Professional drivers are also required to obtain additional mandatory certification, the Driver Fitness Certificate CAM ("Certificado de Aptidão para Motorista") and the Professional Driver Certification CMQ ("Certificado de Motorista Qualificado"). These certifications require additional training with the minimum duration of 280 hours. Additionally, drivers are required to obtain the Children Collective Transportation TCC certification "(Transporte Colectivo de Crianças") to legally perform the carriage of children up to the age of 16 in buses and coaches.

Finally, specific legislation establishes limits to driving and resting times of professional bus, coach and truck drivers. The legal framework provided by European Directive 2003/88/EC and Regulation (EC) 561/2006 is transposed to national law by the Ordinance-Law 983/2007, the Decree-Law nº 237/2010 and the Law 27/2010.

The Vehicle Licensing Regulation ("Regulamento da Homologação CE de Modelo de Automóveis e Reboques, Seus Sistemas, Componentes e Unidades Técnicas"), which regulates the formal and technical requirements for registering vehicles for use on public roads, approved by Decree-Law 16/2010, transposes the European Directive 2009/1/EC.

Similarly, to the findings reported from all other countries, any devices installed inside the vehicle cannot obstruct or restrict the driver's view area. However, no particular mentions can be found regarding the installation of steering wheel-mounted sensors, on-board diagnostics devices nor passive aftermarket camera ADAS, such as Mobileye-like devices. For homologation purposes however, specific driver area of view requirements are specifically defined.

For the specific case of buses, Decree-Law 58/2004 (“Regulamento sobre Disposições Especiais Aplicáveis aos Automóveis Pesados de Passageiros”) provides special provisions concerning vehicles designed for the carriage of passenger, transposing to national legislation the European Directive 2001/85/EC. The legislation for heavy duty vehicles for the carriage of passengers and goods defines in more detail the visibility requirements of such vehicles, however the legislation neglects the installation of aftermarket equipment.

At European Level product liability is governed by the Product Liability Directive 85/374/EEC and the General Product Safety Directive 2001/95/EC. It can however be argued if the equipment’s pertaining *i*-DREAMS setup are covered by the General Product Safety Directive of sector-specific directives for low-voltage electrical product or motor vehicles.

In Portuguese law, product liability and safety is specifically ruled by Decree-Law 383/89, amended by Decree-Law 131/2001 on manufacturer’s liability for defective products and by Decree-Law 67/2003 on the sale of consumer goods. For all matter not foreseen in the previously mentioned special legislation the applicable law is the Portuguese Civil Code, General contract law and Civil statutory liability.

According to the applicable law, there is product liability with respect to damage caused to persons by death or by personal injuries and to property. The producer is liable for the damages caused due to defects in products that he placed on the market independently of fault (strict liability). Under Decree-Law 383/89, if several people are responsible for damages, their liability is joint and several. This means that, in theory, the manufacturer, the importer, the distributor and the “retail” supplier may all be considered responsible for the fault/defect

The consumer (plaintiff) does not have to produce any evidence because the producer is liable for the damages caused, independently of fault. However, if the plaintiff asks for damages caused to persons by death or by personal injury or to property (damage to, or destruction of, any item of property other than the defective product itself), the plaintiff will have the burden of proof.

7.1.2 Steering wheel mounted heart rate monitor

UK:

Cars: No foreseeable issues so long as it is mounted securely to the wheel- if loose or has wires obscuring the steering wheels’ movement it could be considered negligent or using a vehicle in an unsafe condition. This falls under the ‘using a vehicle in a dangerous conditions’ act: http://www.legislation.gov.uk/ukpga/1988/52/section/40A and http://www.legislation.gov.uk/uksi/1986/1078/regulation/100/made

Rail: Nothing regulates against heart rate monitors being in the cabs- some personnel wear their own ‘Fitbits’ etc. already but if staff are concerned their data may be collected or used against them in the event of an incident then unions may block them being installed.

BE: No foreseeable issues so long as the CardioWheel platform is mounted securely to the wheel – if loose or has wires obscuring the steering wheels' movement it could be considered negligent or using a vehicle in an unsafe condition.

This falls under using a vehicle in conditions that might compromise traffic safety (Royal Decree of 15 March 1968 about the general rules on technical conditions of vehicles, Art. 26)

It is advised to have the platform installed by a skilled technician authorised to carry out CardioWheel installations.

DE: No special consideration of steering wheel-mounted equipment in the Road Traffic Licensing Regulations (Straßenverkehrs-Zulassungs-Ordnung - StVZO) in type approval for vehicle parts [StVZO §22]. The steering wheel must ensure easy and safe steering of the vehicle [StVZO §38].

EL: No foreseeable issues, so long as the driver is informed, and the sensor is securely mounted.

PT: No foreseeable issues resulted from the legal framework survey and stakeholder consultations undertaken so long as the CardioWheel installation does not interfere with the normal driving tasks or may considered negligent maintenance that deems the vehicle in an unsafe condition. No special consideration concerning the steering wheel-mounted sensors were found and previous installations, performed with technical assistance from the manufacturer, were made public in the press without giving place to contestation from IMT. Additionally, the installation provides seamless operation and perfectly reassembles the OEM unit so that the system is essentially indiscernible to any unaware driver.

Regarding data protection concerns, there should be no problem as long as consent and data protections mechanisms are established in accordance to the national law and European Generic Data Protection Regulation.

7.1.3 Dash Camera (mounting and data issues)

UK:

Cars: It is legal to have a dash camera fitted but must be out of the 'swept area' of the windscreen wipers or could obscure the view of the road. As covered in Regulation 30 of the Road Vehicles (Construction and Use) Regulations 1986 (SI 1986 No. 1078 as amended) https://www.gov.uk/government/publications/stickers-or-other-items-in-front-and-rear-windscreens/view-to-the-front-and-windscreen-obscuration and http://www.legislation.gov.uk/uksi/1986/1078/regulation/30/made

Police can request to view footage from the camera in the event of a crash- it is illegal to withhold evidence from an officer, so it is a requirement to pass this video on. This could cause issues around who owns the data as the equipment belongs to *i*-DREAMS but is fitted in the participants' own cars.

The power of seizure is covered under the Police and Criminal Evidence Act 1984, http://www.legislation.gov.uk/ukpga/1984/60/section/19. Officers would likely be investigating offences under sections 1-3 of the Road Traffic Act 1988 if a fatal or injury collisions had occurred.

Rail: Nothing regulates against dash cameras being in the cabs but if staff are concerned their data may be collected or used against them in the event of an incident then unions may block them being installed. Currently trains in the UK do not have dash cameras and this is largely due to union resistance (some trams do however have them).

BE: it is legal to have a dash camera fitted to the interior of the vehicle for personal use. For purposes of personal use, a dash camera does not fall under the 'camera law' (Royal Decree 25 May 2018). The camera should not obstruct the view of the driver (Royal Decree of 15 March 1968, Art. 57.1 stipulates that the field of view of the driver must not be obstructed by any objects or postings). Police can request to view footage from the camera in the event of a crash.

DE: It is legal to fit a camera in the interior of the vehicle. According to the road traffic regulations (Straßenverkehrs-Ordnung – StVO), every driver is obliged to make sure that no devices obstruct their view during driving [StVO I.§23(1)]. Therefore immediately after installation it will be important for drivers to sit in the vehicle and check the equipment is not causing them any issues relating to this.

The Federal Data Protection Act (Bundesdatenschutzgesetz – BDSG) states that in video surveillance of vehicles and publicly accessible large-scale facilities for public rail, boat and bus transport, a particularly important interest applies on the protection of life, health or freedom of persons residing there [BDSG §4(1)].

According to the General Data Protection Regulation of the EU, an impermissible permanent filming and storing of public road traffic footage remains prohibited as it violates data protection [Art. 6 DSGVO].

Therefore, dashcams may only be used to record a specific situation and should not be permanently switched on. In addition, the recordings may only be stored for a short time and must not endanger the personal rights of persons. A loop function is recommended, in order to avoid storage.

[https://www.axa.de/das-plus-von-axa/auto-kfz-unterwegs/rechtstipps-kfz/dashcam-erlaubt].

In the event of a crash, the recordings may be admissible as evidence in court [Bundesgerichtshof VI ZR 233/17]

(http://juris.bundesgerichtshof.de/cgi-bin/rechtsprechung/document.py?Gericht=bgh&Art=en&nr=85141&pos=0&anz=1).

EL: No legal framework with regards to dashboard cameras, dash-cameras are not "illegal" in driving regulations, so long as it does not interfere with the visibility or attention of the driver. GDPR issues might arise with regards to recording third-party faces.

PT: An apparently significant difference found between Portugal and the remaining EU countries is the CNPD interpretation of the data protection legislation. It seems odd that despite stemming from the same European Regulation (EU) 2016/679, contrarily to the remaining surveyed countries, according to the CNDP the use of "dash cameras" that record to the exterior of the vehicle is not allowed. Also, the CNPD has previously emitted a legal advice opposing the use of cameras to monitor worker's performance, including drivers.

Traditionally the CNPD is extremely conservative and savvy of privacy and data protection rights, even when dealing with the installation of CCTV inside transit buses, a practice generalised across the EU, even if Portuguese legislation rights hierarchisation gives prevalence to safety and protection over privacy and data protection.

The subject is source of dispute and with the new GDPR, transposed into Portuguese Law 58/2019, the CNDP legal advices are merely consultative or advisory and are no longer binding. As a result, it is the DPO opinion that whenever there is legitimacy video can be recorded and stored so long as the necessary data protection mechanisms are in place. It is however important to bear in mind that, without prejudice to the GDPR and Law 58/2019 provisions, Law 1/2005, amended by Law 9/2012, establishes that video CCTV footage can only be stored for a 30-day period, however the footage can be stored for longer periods if the driver is made unrecognisable and other identifiable data is deleted or there is otherwise expressed consent.

The DPO therefore suggests that in the project employs dash cameras, the systems to not store continuous recordings and only stores video clips associated with event triggers. Additionally, to better protect the partners from data protection liabilities, whenever consent cannot be formally obtained, all identifiable markers, such as faces and licence plates, should be masked and data anonymised.

7.1.4 Mobileye warning system

UK:

Cars: When mounted it must not be in the swept area of the windscreen or obscure the driver’s view in any way- as previously detailed in the Dash Camera mounting section already.

It is also important the drivers are informed not to over-rely on the Mobileye system for detecting dangers, informing when too close to another vehicle etc. but to drive as they normally would. The Highway Code Rule 150 covers this saying “do not rely on driver assistance platforms”

Rail: Any advanced warning system would require a detailed risk assessment to support the installation. Tram Operations Limited have fitted a device to trams that monitors the driver and plays an auditory alert and vibrates the seat if a distraction/fatigue event is detected so it would not be first such device to be installed.

BE: When mounted on the windshield, the Mobileye camera should not obstruct the normal view of the driver (Royal Decree of 15 March 1968, Art. 57.1 stipulates that the field of view of the driver must not be obstructed by any objects or postings).

According to the Road Traffic Act of 1 December 1975, Art. 8.3 stipulates that drivers must be fit to drive, have the required physical qualities and possess the knowledge and skills required for the driving task. The driver must be constantly able to perform all manoeuvres related to driving. This implies (indirectly) that the driver should always pay attention to the road and not over-rely on the Mobileye system for detecting dangers.

DE: When mounted on the windshield, every driver is obliged to make sure that the devices do not obstruct their view during driving [StVO I.§23(1)]. If the device includes a view projection function, this may be used for vehicle-related, traffic-related, journey-related or trip-accompanying information [StVO §23(1a)].

The road traffic act (Straßenverkehrsgesetz – StVG) states that suitable for driving motor vehicles is anyone who satisfies the necessary physical and mental requirements and has not violated traffic regulations or criminal laws significantly or not repeatedly. If, due to physical or mental deficiencies, the applicant is only partially qualified to drive motor vehicles, the driving license authority issues the license with restrictions or conditions, provided that this ensures the safe driving of motor vehicles [StVG §2(4)]. This implies that Mobileye cannot be used as a substitute or assistance to physical and mental driving inefficiencies.

EL: No foreseeable issue.

PT: The Road Traffic Code is neglects the installation of aftermarket devices other than stating that the use of hand-held devices or devices that require continuous attention from the driver are strictly forbidden. There are no mentions to the installation or use of ADAS, either from OEM or third-party.

Mobileye has been installed in plenty road legal vehicles, including those of public institutions, and therefore no foreseeable legal issues were identified, as long as the installation does not obstruct or restrict the driver viewing cone.

Concerning product liability, Mobileye and similar device listen to the vehicle CAN and therefore product liability must be duly examined and warranted.

7.1.5 Mobile phone application (no interaction while driving but might give warnings)

UK:

Cars: It is illegal to use a hand-held mobile phone while driving according to the Highway Code Rule 149 https://www.gov.uk/guidance/the-highway-code/general-rules-techniques-and-advice-for-all-drivers-and-riders-103-to-158. Hands-free usage of a phone is legal.

Rule 150 of the Highway code covers not being distracted by assistance systems https://www.gov.uk/guidance/the-highway-code/general-rules-techniques-and-advice-for-all-drivers-and-riders-103-to-158

Rail: Nothing regulates against mobile phone use in the cabs. Many drivers are now provided with phones/tablets that can be used for operational purposes. E.g. the railway rule book is on a mobile application which drivers can use when they need to check a rule or procedure. Individual companies can use these devices as they wish (put their own local procedures on, use for distributing emails etc.) but again must risk assess and put in good controls. Examples of these may include:

- The device can only be used for operational purposes and what can be used/downloaded is restricted (communications, games etc. on the devices are limited to prevent temptation while driving)
- The devices can only be used when the train or tram is not in motion – when in motion the device must be cradled or off in a bag or out of sight
- The device cannot be used when the driver is conducting other safety critical activities (e.g. opening or closing doors)

BE: According to the Road Traffic Act (Royal Decree of 1 December 1975, Art. 8.4), it is illegal to use a hand-held mobile phone while driving, hands-free usage of a phone is legal.

DE: An electronic device can be used by a driver if its instructions and commands are based on sound and voice and only if a short glimpse is required. This rule applies to mobile phones as long as they are used for navigation purposes [StVO §23(1a)].

EL: It is illegal to use a mobile phone while driving in hand-held mode, hands-free usage of a phone is legal.

PT: Alike all EU countries, the use of mobile devices or any other hand-held devices during driving is forbidden. The Road Traffic Code also mentions specifically the prohibition to use devices that required continuous attention, safeguarding the use of devices with voice and/or gesture control. It is therefore recommended to implement a simple voice commanded interface to complement a display lock functionally that inhibits driver touch input whenever the vehicle is in motion.

7.1.6 OBD-II port interrogation

UK:

Cars: It is not illegal to have devices plugged into the OBD-II device port. It must not affect the condition of the vehicle and the output must not distract the driver though. Furthermore, some public concerns have been raised regarding the vehicle warranty becoming void when an OBD-II device has been mounted in the vehicle. Stated reasons by some OEMs are the potential interference by the OBD-II device with critical vehicle systems leading to potential safety issues when the vehicle is in motion. It may be necessary to have resources or answers ready to appease potentially anxious participants that no harm will come to their vehicle from such fitment and that it is a legal practice.

Rail: There are no OBD ports on the railway; this is not applicable.

BE: there is no Belgian legislation stating that it is illegal to install an OBD-II logger in a vehicle. However, the Royal Decree of 15 March 1968 about the general rules on technical conditions of vehicles, Art. 26 states that no vehicle is allowed to be used on the road when it is in a state of maintenance or operation where traffic safety is compromised, irrespective of the vehicle inspections carried out by accredited organisations. This implies that an OBD-II logger should not interfere with the vehicle's critical safety systems, i.e. only reading data from the OBD-II standardised data link connector.

DE: There is no law stating that the use of devices plugged into the OBD-II device port is illegal. There is no special consideration of OBD-II equipment in the Road Traffic Licensing Regulations (Straßenverkehrs-Zulassungs-Ordnung - StVZO) in type approval for vehicle parts [StVZO §22]. The device should not distract the driver, other than a very short glimpse [StVO §23(1a)].

EL: Not illegal to have OBD-II devices, however there is not a "written" regulation on this.

PT: From the legal framework perspective there were not found to be any foreseeable legality concerns.

7.1.7 Implications for the study from legal considerations

UK:

- No foreseeable legal blocks to technology fitment or use
- Recommend the creation of a project fact sheet detailing equipment, who to contact etc to keep in the glovebox in case stopped and need to explain data
- Need professional fitting of most equipment- Dashcam and Mobileye must be out of 'swept area', CardioWheel must not be movable on the wheel (firmly attached) and no trailing wires to block drivers' movements
- Need to consider a project wide data policy for if witness dangerous driving on the videos (no legal but perhaps moral obligation to hand over to authorities depending on frequency and severity)
- Need project wide procedure for giving dash camera and any other requested footage to the Police (legal responsibility to share if they request)
- Provide explanation to the user about safe use of installed equipment, especially when the vehicle is moving (i.e. systems do not replace driver's responsibility to observe the road and react accordingly, the driver should over-rely on the system warnings, the *i*-DREAMS technology is only 'advisory')
- Any use in the rail sector is likely to require detailed risk assessments, control procedures put in place to minimise risk and union approval

BE:

- No foreseeable legal blocks to technology fitment or use
- Create a project fact sheet detailing equipment, who to contact etc to keep in the glovebox in case stopped and need to explain data
- Need professional fitting of most equipment- Dashcam and MobilEye must be out of 'swept area', CardioWheel must not be movable on the wheel (firmly attached) and no trailing wires to block drivers' movements
- Need to consider a project wide data policy for if witness dangerous driving on the videos (no legal but perhaps moral obligation to hand over to authorities depending on frequency and severity)
- Need project wide procedure for giving dash camera and any other requested footage to the Police (legal responsibility to share if they request)
- Provide explanation to the user about safe use of installed equipment, especially when the vehicle is moving (i.e. systems do not replace driver's responsibility to observe the road and react accordingly, the driver should over-rely on the system warnings, the *i*-DREAMS technology is only 'assistive')

DE: Same as above (for BE and UK)

EL: No foreseeable legal blocks to technology fitment, however there is a need for professional fitting of most equipment

PT: Same as above (for BE and UK) however, it is believed important from a driver recruitment point of view to ensure the project policy in the event of recording of illegal behaviour simply states that it will not be reported in any way (as there is no legal necessity to do so) or potential participants may be put off from taking part

7.2 Insurance issues

Insurance issues can come in the form of the participant's vehicle being modified with the *i*-DREAMS technology, the use of the vehicles in a study setting and for the partners' institutions (such as universities) in terms of whether public liability insurance requires being taken out.

UK: The investigation into possible insurance have begun but are in the early stages. The university's Insurance Officer has been engaged with and has stated that insurance sign-off will be needed for the on-road trials before ethical clearance is granted. There will need to be more in-depth discussions with the Insurance Officer as there is some uncertainty whether public liability insurance adaption will need to be made to the university's policy to cover the trials and also whether product liability insurance will need to be taken out as a result of some of the products not being off-the-shelf units. Whether product liability insurance responsibilities fall on Loughborough (as they are carrying out the study), U-Hasselt only (as project lead), the technology manufacturers (or a combination of these) still needs to be ascertained. Similarly, very detailed information needs to be given to the Insurance Officer and talked through with them to see if amendments are required to the University's vehicle insurance policy to cover the Design School's Departmental Vehicle once the equipment has been fitted. The Insurance Officer does not see any major barriers to prevent the go-ahead of any elements of the study, but in-depth discussions are needed to ensure adequate cover from all fronts.

BE: After consultation with experts from AXA Belgium, the largest private vehicle insurer in the country, no critical insurance issues were identified with the installation of the *i*-DREAMS monitoring and intervention technology in the vehicles. The core business of an insurance company is to cover the damages for their client in case of a crash (civil liability, all-risk insurance). According to the general terms and conditions of the all-risk car insurance contract, there is no obligation for the client to inform the insurer about installation of third-party equipment in the vehicle (except when the client wishes to also insure the material damage to the equipment itself). Moreover, AXA even provides a reduction of up to 10% of the insurance premium when the client installs additional safety equipment in the vehicle (including blind spot monitor, lane keep assistant, parking assistant, automatic emergency braking, attention monitor assist, or adaptive cruise control).

The point of view of AXA, communicated by email to the project coordinator, is as follows:

- Under no circumstances the use of the below telematics devices in a vehicle insured by AXA can be used to justify the termination or nullification or amendment of the insurance contract.
- In case of accident, <u>the presence of telematics</u> will not be used as a (unfavourable for the customer) motive to:
    - interfere in the claims management by claiming, for instance, hindrance to visibility, distraction, etc
    - nullify or change the coverage detailed in the contract, for instance, decreasing the due allowance.
- However, in case of an accident-related litigation and upon request of a judge, <u>telematics data</u> could be used as evidence to establish the responsibility of the driver in an accident (e.g. in case of multiple vehicle collision) or for fraud detection (e.g. vehicle theft).
- To ensure road safety, we recommend avoiding any interaction between telematics and the driver while he is driving (e.g. smartphone application notification, wearables

signals, etc.) except for safety warning signals (e.g. dashcam warning of danger ahead).

- By telematics devices we mean:
    - Smartphone applications
    - OBD devices
    - Dashcams (incl. Mobileye)
    - Connected wearables
    - Telematics equipment
- AXA wholeheartedly support initiatives, such as *i*-DREAMS, aiming to better understand driving behavior, ease eco-responsible mobility, and improve mobility safety.

AXA Belgium will provide an official letter to Hasselt University with an official statement on their behalf. UHasselt will further seek the additional advice from Assuralia, the Belgian professional association of insurance companies.

UHasselt will also subscribe to a public liability insurance and physical accident insurance as part of the execution of the simulator and on-road trials in the *i*-DREAMS project in Belgium. This insurance will cover any damages (material, immaterial and physical) of participants as a result of crashes the usage of *i*-DREAMS technology.

DE: To address insurance related aspects, the biggest car insurance companies in Munich were identified; then their terms and conditions were examined. This included Allianz, AXA and Sparkassen DirektVersicherung AG. All of them state that only the parts of the car that are necessary for driving are insured; this means that they in general don't insure equipment such as navigators, cameras etc. Some however offer discounts for ADAS (e.g.: die Bayerische for installing a cam on the car).

Although there is in general no explicit mention about auxiliary devices jeopardising the insurance conditions, insurance companies were directly contacted to minimise the risk of missing information.

The contacted companies are: Allianz, AXA, VHV, Sparkasse DirektVersicherung AG, WGV, Europa, Generali, ERGO, die Bayerische, Die Deutschen Versicherer. Out of these, Sparkassen DirektVersicherung AG and Die Deutschen Verischerer gave positive feedback.

The former replied by saying that since the equipment to be installed does not in any way increase the risk to be insured, they have no reservations about the insurance plan. This continues to be fully covered according to their general terms and conditions (AKB).

The latter, which is the association of private insurers in Germany, stated that the equipment does not affect the insurance plan if it does not increase the risk. However, they mentioned that they cannot provide binding information for individual cases and therefore advised us to contact the specific insurer of the vehicle, which will then take the decision based on the AKB (terms and conditions) on which the contract is made.

EL: Possible insurance issues are still being investigated at this time, however no issues above and beyond what other partners have suggested are expected.

PT: After preliminary consultation with the main insurance provider for Barraqueiro Transportes, S.A.'s fleet no critical insurance issues were identified regarding the installation of the *i*-DREAMS monitoring and intervention technology in the vehicles and the installation of third party device incompliance with the legal framework should not affect the insurance liability coverages. However, a more in-depth assessment is being carried out by the insurer to guarantee that, in accordance to the outcome of the survey performed by the consortium, the installation and use of all components of *i*-DREAMS system are indeed in compliance with national and European legal provisions.

Since vehicles participating the trial are property or leased to Barraqueiro Transportes, S.A. all necessary measures to safeguard the project and company liability will be assessed and implemented. If necessary and within budget, Barraqueiro Transportes, S.A. will also subscribe complementary liability insurance as part of the execution of the simulator and on-road trials in the *i*-DREAMS project in Portual. This insurance should cover any damages (material and physical) of participants as a result of accidents that might result from the usage of *i*-DREAMS technology.

7.3 Ethical issues

It is important in the planning of the project to ensure that appropriate ethical considerations are taken into account. All trial partners will need to go through their institution's own ethical clearance process and the requirements for this may vary based on country, transport type and institution. For this reason, early considerations and consultations with relevant advisors needs to be undertaken as early as possible, ensuring issues that may arise can be dealt with in a timely manner and while plans for the trials are still being formed, so are more readily adaptable. This section details what has currently taken place regarding ethical clearance within the project.

UK: The Loughborough Design School's ethics advisor informed that there are no foreseeable major barriers with the proposed trials from an ethical standpoint. It was recommended that the ethics application be submitted in two separate rounds, the first for the simulator trials, which is unlikely to require approval above the normal ethics checklist procedure. Secondly the on-road trials should have a separate ethics application which may require full ethics board approval, the process of which takes approximately one month. It was advised that it would be more efficient to only submit ethics proposals once all details have been finalised, as opposed to submitting early and then putting in multiple amendments as details change. For this reason, the ethics proposals have not yet been submitted.

BE: A Research Ethics approval for the simulator and on-road experiments in the *i*-DREAMS project has been provided by the Hasselt University Social-Societal Ethics Committee (SSEC) on October 16, 2019 with reference REC/SMEC/JA/189-132.

DE: TUM is in consultation with the university ethical committee (Ethikkommission) who advised to divide the approval in two parts: one for the simulator experiment (Stage 1), and another for on-road experiments (Stages 2 to 4). The final document is expected to be submitted before the end of 12/19.

EL: Ethical clearance will be sought through the normal university procedures once details of the study have been more finalised, no barriers are foreseen at this point in time.

PT: The Portuguese trial within *i*-DREAMS is different to those for other trial partners, since no local research institutions is involved. As a result, it is not clear which Research Committee will review and eventual approve a Research Ethics Proposal.

After consulting with four higher education institutions, with their own Research Ethics Committee or specialising in the Business Ethics, none of them agreed to review the Research Ethical Proposal on grounds that the proposal is outside their scope.

As a result, Barraqueiro Transportes, S.A. is in touch with alternative higher education and research institutions to assess their availability to review the ethics proposal. In parallel, the necessity of submitting the Proposal to the National Ethics Committee for Clinical Trials CEIC ("Comissão de Ética para a Investigação Clínica") or the establishment of a partnership with a local research institution, within the scope of *i*-DREAMS trials, are under consideration.

7.4 GDPR compliance

Compliance with GDPR regulations and applicable Belgian law has been assessed by the Data Protection Officer of Hasselt University. The assessment with detailed feedback and answers is available at Hasselt University.

Aspects of the project may initiate ethical considerations, including data privacy and protection issues. Many of these issues need to be addressed under the guidelines outlined in the Consortium Agreement, and some may need amendments to the Grant Agreement. Specifically, Work Package 10 will focus on ethical requirements that the project must comply with.

Data collected through the *i*-DREAMS project may contain personal or potentially sensitive information, and therefore may pose risks for the privacy of individuals. Therefore, it is important that there is compliance with GDPR. D1.2 specifies the data management plan, outlining the procedures to ensure compliance with ethical considerations. The document will be updated as necessary throughout the project. D1.2 describes the data management life cycle for the data to be collected, processed and/or generated by the *i*-DREAMS project. D1.2 considers several factors, such as data handling during and after the project, how the data will be collected and processed, which methodologies and standards will be applied, whether the data is shared or made open access, and how data will be preserved is all considered. Specifically, Section 5 focuses on data security and protection, including compliance to GDPR, personal data and anonymisation. Importantly for all partners involved in the processing of personal data, relevant data protection measures should be applied in accordance with the General Data Protection Regulation (2016/679) and *i*-DREAMS privacy policy. Please refer to D1.2 for further information.

GDPR is universal cross all countries within the project so the above information is relevant for other trial partners also. Further investigation into GDPR and local data protection laws will be investigated at a later date to ensure full compliance.

8 Communication plans

The i-DREAMS project is very complex with it occurring across five countries using four different modes of transport, with different leaders at each site and across work packages. For this reason, communication internally across trial partners (including technical partners) and externally with participants requires detailed and efficient procedures to ensure success. Due to the early date of this deliverable a specific communication plan has not yet been developed but will be done so in the course of Task 5.1. The project itself already has pre-defined processes for communication such as mailing lists separated by work package, a means of sharing files across a common file sharing platform etc. The communication plan for Task 5.1 is looking more specifically at communication when the trials are taking place, between partners, with participants and to those outside the project.

8.1 Internal communication

To ensure efficient communication between partners, once simulator and on-road trials are under way, a step-by-step procedure will be developed. This process will be used by all trial partners and will have different processes based on the needs of the task, for example a specific plan for cross sharing of lessons learnt as equipment is fitted, a separate process for communicating equipment failures and another for updating each other on progress. In line with the FESTA Handbook recommendations the processes employed are likely to become more refined as the planning stages end and the trial dates draw nearer. The communication processes will have an opportunity to be stress tested in the first round of simulator trials in the first instance and it will be important to learn during this process and transfer these lessons to the on-road trial procedures.

8.2 External communication

How the project will communicate with participants both on a routine basis and in the event of adverse events needs to be considered. This will be standardised across trial sites and transport types to ensure best practice is followed by all. Similarly, the FESTA Handbook also advises having a procedure ready if the press becomes aware of any issues like a crash with an equipped car or data released early (such as on social media or via a participant) but which is not finalised and not intended for public release.

A social media policy will also be created, it is noted that trials are a good opportunity for photos and social media postings but an easy to follow procedure and checklist will be needed to ensure legal (including GDPR) processes are followed, as participants may feature in these, and that only relevant, approved, information about the trial is released on social media at appropriate times. Therefore, what information can be shared when will need to be pre-considered. These, and many other considerations will form the basis of plans put in place.

Work Package 9 also covers dissemination information and plans for the project so close collaboration will be needed between Task 5.1 and WP9 to ensure consistency and that duplication does not occur for the planning of communication practices. In particular, Deliverable 9.3 is a dissemination plan so it will have shared ground with Task 5.1 and it aims to ensure key stakeholders are involved and up to date with the project. It will also allow for stakeholders, other related parties, and the general public to be informed of the progress and results of the project at regular intervals. This plan will also be updated in D9.4. Close collaboration is clearly needed across these deliverables and Task 5.1.

9 Conclusions

The aim of this deliverable was to outline initial details for the simulator and field study organisation and support. This required sign posting what needs to be done to achieve a successful FOT and what progress towards these activities has currently occurred.

This deliverable detailed the guidelines from the FESTA Handbook which are relevant to *i-*DREAMS*.* This ultimately led to the development of two checklists created specifically for *i-*DREAMS, separately depicting the actions required in the planning stages and then the operational considerations of the trials once underway.

It was crucial for the deliverable to first know the ‘destinations’ the project was heading towards to ensure future plans could enable the project to successfully reach them. Therefore, the aims, hypotheses and KPIs of the relevant work packages for planning and carrying out of the FOTs were developed as far as possible at this point in the project. These might be subject to minor change but by having introduced them in this deliverable the thinking about, and forming, of these parameters was an important first step.

All that was currently known and planned for the FOTs and simulator trials were outlined in separate sections. This included planned number of participants, equipment needed, budgeting information and timelines for current and future actions.

Possible barriers in the form of legal, insurance and ethical issues were then examined on a country by country basis and for all transport modes which will be investigated within those borders. No unsurpassable hurdles were foreseen after this process in terms of feasibility and legality of the *i*-DREAMS technology platform being used or participants having issues with insurance. No major ethical problems have been identified in terms of preventing the clearance from ethics advisory boards, although this process is noted as being a more complex procedure in Portugal, due to trials not being run by an academic institution, resulting in finding an appropriate ethics board to sign off clearance proving to be more of barrier.

Finally, the reasoning behind the need for a detailed communication plan was discussed and what might need to be considered in the future when creating such plans later in this task was laid out.

Next crucial steps include finalising of the technology being used in the *i*-DREAMS platform to define, develop, test and validate the concept of a context-aware ‘Safety Tolerance Zone’ for driving. Further development of the communication plan including outlining precise procedures for communicating internally in terms of shared learning and flagging of technical issues, and externally, with participants, in both routine and adverse event conditions. In both the planning and operational stages, the checklists in Annex 1 should now be consulted on a regular basis to ensure crucial steps for successful FOT planning and execution are not omitted.

10 References

EuroFOT Deliverable 11.3 Final Report https://www.eurofot-ip.eu/download/library/deliverables/eurofotsp120121212v11dld113_final_report.pdf

FESTA Handbook Version 7 (2018). Accessed November 10th 2019. Retrieved from https://connectedautomateddriving.eu/publication/festa-handbook-7th-version/festa-handbook-version-7/

Franzén, S.E., Karlsson, M., Morris, A.P. and Welsh, R., 2012. Widening the Use of the FOT Methodology Development Based on Experiences from the TeleFOT Project. Procedia-Social and Behavioral Sciences, 48, pp.1826-1836.

i-DREAMS Privacy Policy. Accessed 09/12/2019. Retrieved from https://iDREAMSproject.eu/wp/privacy-policy/

i-DREAMS Project Deliverable 1.2 Data Management Plan (DMP)

i-DREAMS Project Deliverable 3.1 Framework for operational design of experimental work in i-DREAMS

i-DREAMS Project Deliverable 3.4 Experimental protocol

i-DREAMS Project Deliverable 9.4 Update of dissemination plan

Prologue Recommendations for a large-scale European naturalistic driving observation study Deliverable D4.1
https://prologue.kfv.at/fileadmin/content/Dokumente/PROLOGUE_D4.1_01.pdf

Michon, J.A., 1985. A critical view of driver behavior models: what do we know, what should we do? In Human behavior and traffic safety (pp. 485-524). Springer, Boston, MA.

Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (Text with EEA relevance); https://eurlex.europa.eu/eli/reg/2016/679/oj

U-Drive Deliverable 3.4 Summary of OS preparations https://erticonetwork.com/wp-content/uploads/2017/12/UDRIVE-D34.1-Summary-of-OS-operations.pdf

*U-Drive Deliverable 35.1 Lessons learned from OS preperations*https://erticonetwork.com/wp-content/uploads/2017/12/UDRIVE-D35.1-Lessons-learnt-from-OS-operations.pdf

Annex 1: Road maps for simulator and on-road trials

Adapted from checklists in the FESTA Handbook https://connectedautomateddriving.eu/publication/festa-handbook-7th-version/festa-handbook-version-7/ pages 180 to 213.

Note: not necessarily in time order- some activities run in parallel, others will need re-addressing as the study planning and testing progresses.

FOT Planning checklist

FOT Planning actions checklist	Person/Team/Organisation Responsible for Activity	Done
Define the research questions and prioritise them	Work Package Leaders	
Define the aims and objectives of the FOT, in conjunction with relevant stakeholders	Work Package Leaders	
Determine the constraints which may prevent the aims and objectives from being met	WP 3,4 and 5 leaders	
Sign off on the aims and objectives of the FOT	Co-ordinator	
Formulate hypotheses to be tested, deriving from research questions	Work Package Leaders	
Ensure that all terms and phrases making up the research questions and hypotheses are clearly defined and unambiguous. This will facilitate interpretation of the FOT outcomes and comparisons with previous and future FOTs	Deliverable leaders	
Identify the sensors and sensor requirements for obtaining the required measures	WP3 and 4 lead	
Identify use cases/situations in which systems and functions are to be tested	T3.4 lead	

Check that use cases may be practically tested and reproduced with the requested statistical relevance	WP3, 4 and 5 leads	
Define methods, tools, requirements and procedures for acquiring, storing, transferring, de-coding, reducing/transcribing, filtering, backing up and verifying the data	T3.5 and T5.5 leads	
Sign off on study design, methods and tools, questionnaires and associated procedures	Co-ordinator	
Determine timelines for completion of activities (Gantt charts), tasks and sub-tasks and who is responsible for them	WP and task leaders	
Identify and document in the Gantt chart the dependencies that exist between different activities, tasks and sub-tasks	WP and task leaders (co-ordinator to have overview for project as a whole)	
Where relevant, allow sufficient time between vehicle allocations for platform maintenance and verification, servicing and repairs to be undertaken	Trial partners	
Undertake a risk assessment for the simulator trials/ FOTs and plan contingencies as required	Trial partners	
Seek specialist advice to identify relevant legal and ethical issues	WP5 and trial partners	
Resolve all legal and ethical issues that can be identified in advance	WP5 and trial partners	
Seek expert advice regarding liability issues and to ensure insurance provision is adequate for all foreseeable eventualities	WP5 and trial partners	
Ensure that vehicle type approval and warranty requirements are adhered to in spite of the modifications (implementation of data logging equipment and possibly systems to be evaluated, etc.)	Trial partners	
Create contracts and/or agreements with all relevant parties (e.g. vehicle leasing organisations, suppliers, road operators, traffic centres, consultants, fleet managers, researchers etc.) for all relevant issues (e.g. data collection, provision and usage, theft, insurance, privacy, duty of care, property, disposal of vehicles after the study, etc.)	Trial partners	

Agree on project issues which are confidential, and implement mechanisms for safeguarding their confidentiality	WP leaders	
Develop a manual for conducting the simulator trials/ FOTs that documents critical procedural knowledge- this should be detailed enough that new members of the team can use it to run the experiment without feedback from current staff to add resilience in case of loss of the original team	WP3 and 5 leads	
Develop and implement a communication plan (internal and external) with input from steering committee	WP5 and Task 5.1 leads	
Ensure that there is appropriate control of communication with the media, through the appointed media spokesperson. For EU projects, involving multiple partners, it may be necessary to appoint more than one media spokesperson	Each project partner	
Specify data to be logged (measures and sampling rate)	WP3 and 4 leads	
Source, purchase and/or develop systems for logging and transferring the data that meet the above functional requirements and performance specifications	WP4 lead	
Prepare a platform installation/integration manual describing standardised procedures	WP4 lead	
Design, develop and implement systems and procedures to allow users to report technical problems in a timely manner	WP4 and 5 leads	
Design, develop and implement systems and procedures that allow researchers to monitor participant progress (e.g. to ensure they are adhering to study requirements)	WP5 lead	
Design, develop and implement a database for storing data logged from the test platforms	Task 3.5 and T5.5	
Design, develop and implement a database for storing the subjective data collected from participants (e.g. from questionnaires, focus groups, feedback lines etc.)	Task 3.5 and T5.5 and trial partners	

Develop a recruitment strategy, including user entry and exit requirements and procedures	T5.2 lead	
Develop recruitment materials and procedures	T5.2 lead	
Design and develop briefing and training materials	WP3 and 5 leads	
Design and develop a FOT platform user manual	WP3, 4 and 5 leads	
Design and document the procedures for delivery of the briefing and training to the simulator/ FOT participants	WP3, 4 and 5 leads	
Create a mini operating manual to keep in the vehicle and prepare written materials that can be taken away after the briefing sessions	WP4 and 5 leads	
Create a written statement for the participants to keep (in the vehicle) which confirms their participation in the FOT and the nature of vehicle modifications—in case they are challenged by police or other authorities.	Trial partners (overseen by WP5 lead)	
Develop a protocol for pilot testing FOT equipment, methods, procedures, evaluation tools and materials (including training, briefing materials and data collection, downloading and analysis procedures)	WP3 and 5 leads	
Sign off on all aspects of the FOT design and procedures	Co-ordinator	

FOT Implementation checklist

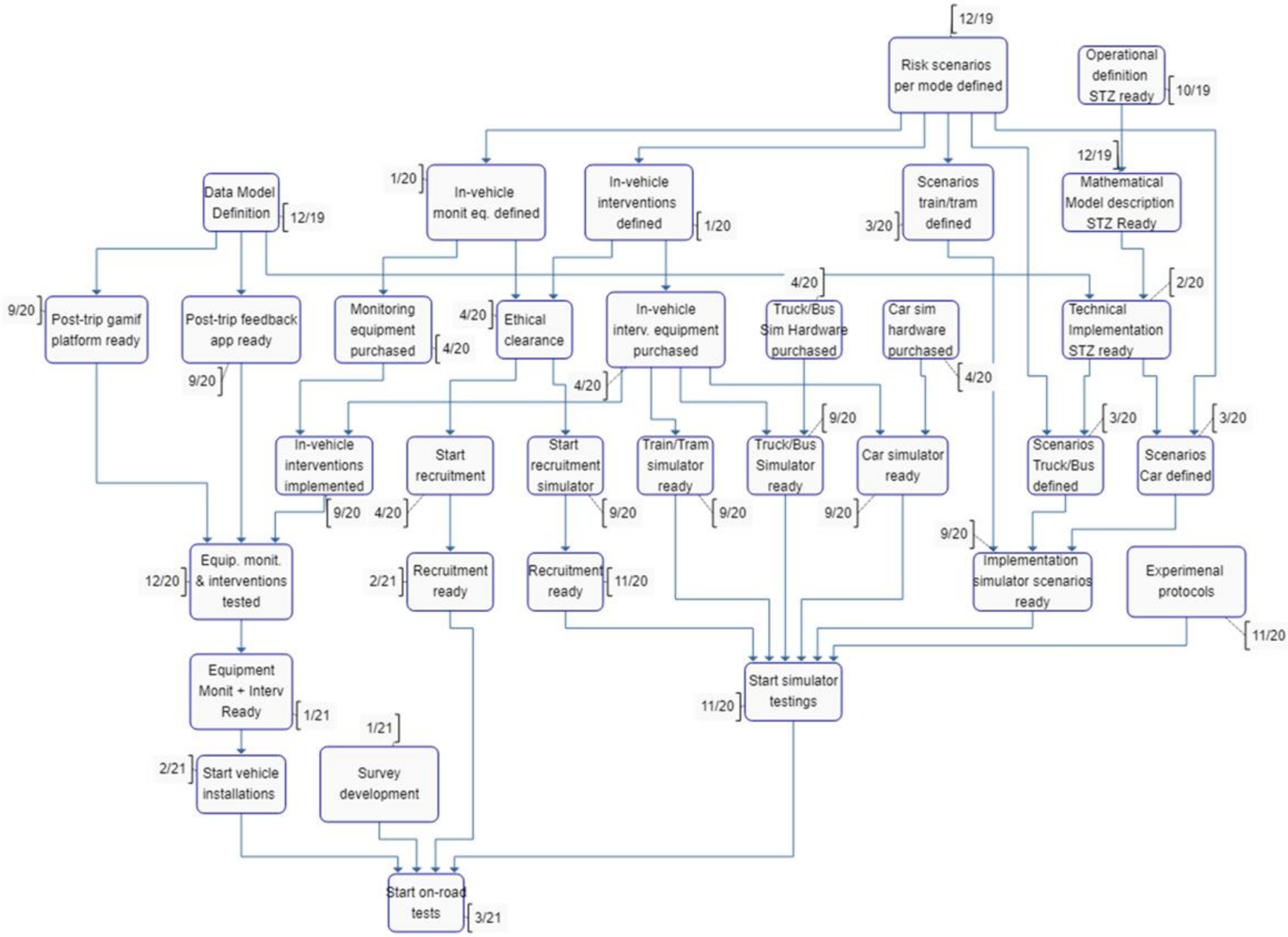
This list can be updated with specific individuals' names once nearer to the trials taking place.

FOT pilot and main trial implementation checklist	Person/Team/Organisation Responsible for Activity	Done
Recruit, brief and train pilot participants	Trial partners	
Equip pilot participant vehicles	Trial partners	
Run pilot study	Trial partners	
Fine tune FOT platforms and technologies, systems, procedures, evaluation tools and protocols, as required, on the basis of the pilot data yielded	WP3, 4 and 5 leads	

Recruit main trial participants as per recruitment strategy	Trial partners	
If fleet drivers are recruited via a fleet owner or manager, ensure consent and buy-in from individual drivers	Trial partners	
Deliver relevant training in FOT procedure and equipment use- supply the pre-made training resources to take home	Trial partners	
Supply the pre-written statement which confirms their participation in the FOT and the nature of vehicle modifications—in case they are challenged by police or other authorities and instruct them to keep this in the vehicle at all times	Trial partners	
Obtain informed consent of participants before they are allowed to participate in the FOT	Trial partners	
Equip test platforms with data collection and transfer systems	Trial and tech partners	
Assess vehicles against relevant certification procedures to ensure that vehicles are safe, roadworthy and comply with all relevant national, state and territory laws, treaties and other protocols	Trial partners	
Ensure that all vehicle modifications that affect primary safety are signed off by a competent engineer or appropriate testing authority	Trial partners	
Respond in a timely manner to systems and procedures if users report technical problems	Trial and tech partners	
Run without FOT technology platform to collect baseline driving data	Trial partners	
Equip test platforms with the FOT systems to be evaluated once baseline data has been collected	Trial and tech partners	
Monitor participant progress (e.g. to ensure they are adhering to study requirements) as per pre-planned procedure	Trial partners	
Administer questionnaires and implement other data collection methods at pre-determined intervals	Trial partners	
Collect, enter into database (unless automated) and store subjective data	Trial partners	

Record, download and store objective (i.e. logged) data	Trial/ WP6 and 7 partners	
Monitor for, collect and document data on technical problems and user feedback	Trial/ tech partners in collaboration with WP7	
Commence preliminary evaluation of data, to identify instances of dangerous driving and any other findings of interest/relevance to FOT outcomes	WP6 and 7 leads	
Repair and re-deploy platforms (as required)	Trial and tech partners	
Report dangerous driving behaviours (if legally required)	Trial partners	
Conduct exit interviews with users and the other relevant actors	Trial partners	
Remove platform and equipment from vehicles	Trial partners	

Annex 2: *i-*DREAMS critical pathway



Annex 3: DSS driving simulator specifications

DSS	Car Simulator	Truck Simulator
		
Description	Based on Peugeot 206, using OEM parts. Modular and expandable Easy to transport, assemble and disassemble.	Mock-up or ergonomic truck/bus driving position Modular and expandable Easy to transport, assemble and disassemble
Driver Controls	• Fanatec Podium DD1 20Nm force feedback steering motor • Car steering wheel with CardioWheel Technology • OEM blinker/light controls. • Fanatec Clubsport V3 inverted pedals with 90kg Loadcell brake + vibrator on brake and accelerator. • Fanatec Clubsport SQ V1.5 man/seq Shifter	• Fanatec Podium DD1 20Nm force feedback steering motor • Truck steering wheel with CardioWheel Technology • OEM blinker/light controls. • Fanatec Clubsport V3 pedals with 90kg Loadcell brake + vibrator on brake and accelerator. • Fanatec Clubsport SQ V1.5 man/seq Shifter
Frame Material	Aluminium T-slot profile	Aluminium T-slot profile
Frame Dimension, excl. TV's	Length: 1800mm Width: 1350mm	Length: 1300mm Width: 800mm
Full Dimensions, incl. TV's	Length: 1800mm Width: 3300mm Height: 1550mm	Length: 1300mm Width: 3300mm Height: 1550mm
Visual	3x Samsung Q70R 49inch TV, 135° Horizontal FOV	3x Samsung Q70R 49inch TV, 135° Horizontal FOV
Instrumentation	Original Instrument Cluster	TBD
Software	STISIM Drive 3	STISIM Drive 3
PC specifications	Intel i7 9700K GeForce RTX 2070 Super 16GB DDR4 RAM 512 GB SSD	Intel i7 9700K GeForce RTX 2070 Super 16GB DDR4 RAM 512 GB SSD
Electrical requirements	1 Schuko Type Socket 1x230VAC + PE, protected by an overcurrent device of 16A and residual current device of max. 300mA.	1 Schuko Type Socket 1x230VAC + PE, protected by an overcurrent device of 16A and residual current device of max. 300mA.

Electrical Specifications	Max power: 3.2 kW, 14A 230VAC Internally protected by 16A automatic fuse.	Max power: 3.2 kW, 14A 230VAC Internally protected by 16A automatic fuse.

Annex 4: FOERST driving simulator specifications

Foerst	FPF car simulator
	
Description	Triple screen car driving simulator, using OEM car parts.
Driver Controls	27cm steering wheel Pedals (throttle, brake, clutch) 5+R gear manual gearbox Blinker + Light + horn controls
Frame Dimension, excl. TV's	Length: 1800mm Width: 780mm
Full Dimensions, incl. TV's	Length: 1800mm Width: 32300mm
Visual	3 x 40 inch TV (1920x1080), 170° horizontal FOV
Instrumentation	OEM Instrument Cluster
Software	F10 Driving software

Annex 5: STISIM 3 parameter overview

Elapsed Time	Seconds
Longitudinal acceleration	Meters/second²
Lateral acceleration	Meters/second²
Longitudinal velocity	Meters/second
Lateral velocity	Meters/second
Total longitudinal distance travelled	meters
Lateral lane position, relative to centreline	meters
Current driven vehicle lane	/
Current roadway curvature	1/meter
Vehicle heading angle	degrees
Steering wheel angle input	degrees
Longitudinal acceleration due to throttle	Meters/seconds²
Longitudinal deceleration due to brake	Meters/seconds²
Current traffic signal light position	/
Running compilation of driver crashes	/
Minimum time to collision	seconds
Data marker flag	/
Driver vehicle speedometer value	Kilometres/hour
Vehicle yaw rate	Radians/second
Current transmission gear	/
Steering input counts	/
Gas pedal input counts	/
Brake pedal input counts	/
Scene viewing angle	degrees
Total pitching angle	radians
Total rolling angle	radians
Steering wheel angular rate	Radians/seconds
Minimum distance to vehicle in own lane	meters
Minimum distance to vehicle in opposing lane	meters
Minimum time to collision in own lane	seconds
Minimum time to collision in opposing lane	seconds
Computer time stamp	date
Total inertial heading angle	degrees
Current status of the digital input port on the secondary I/O device	
Current speed limit	Meters/second

Number of the most recently activated triggered event	/
Current speed limit	Kilometres/hour
Engine rpm value	RPM
Clutch pedal input counts	/
Hand wheel torque	Newton meters
Left indicator state	/
Right indicator state	/
Running compilation of driver tickets	/
Percentage Gas pedal	%
Percentage brake pedal	%

Annex 6: F10 driving software parameter overview

Time	Milliseconds
x-position vehicle	Meters
y-positions vehicle	Meters
z-position vehicle	meters
Road number of vehicle	/
Vehicle direction	BOOL
Vehicle distance from start	Meters
Vehicle direction compared to road direction	Degrees
Distance of vehicle from centre of the road	Meters
Total distance driven	Meters
Vehicle speed	Kilometres/hour
Brake pedal position	%
Gas pedal position	%
Clutch pedal position	%
Chosen gear	/
Engine RPM	RPM
Headway distance to vehicle ahead	Meters
Distance to left road barrier	Meters
Distance to right road barrier	Meters
Steering wheel position	Degrees
Time headway	Seconds
Time to line crossing	Seconds
Time to collision	Seconds
Lateral acceleration	Meters/seconds²
Longitudinal acceleration	Meters/seconds²
Event visible flag	BOOL
Event distance	Meters
Number of the most important driving failure	/
State date of most important driving failure	Timestamp
Number of next driving failure	/
Additional date to failure 2	Timestamp
Number of further driving failure	/
Additional date to failure 3	Timestamp